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FUNCTIONAL PERIODICITY

An Experimental Study of the Mental and Motor Abilities of Women During Menstruation

By

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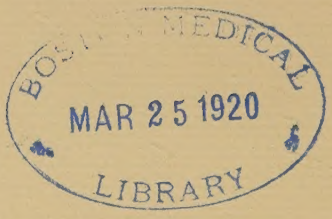

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II

AIM, SCOPE, AND METHOD OF THE EXPERIMENT

In planning this experiment it was deemed wise to select tests which have already been used by psychologists to measure relatively small differences, and which have been found to be susceptible to a wide variety of influences. Two motor tests were therefore selected on this basis,—the familiar tapping test, and a steadiness test; and two mental tests,—color naming and saying opposites. A measure of motor fatiguability was also included, and tests were made of speed and accuracy in typewriting. It would be, of course, highly desirable to perform experiments for sensory capacity, suggestibility, reaction time, endurance in working for long periods, but it was not possible to include all these within the scope of the present study.

The tests were given *daily,* under uniform conditions; at the same hour (immediately after dinner in the evening), by the same person, and in the same order. They were simply included among the regular routine duties of the subjects. Any unavoidable departure from the strictly usual, such as a slight difference in the hour of testing, headache on the part of any subject, nervous strain during the day, such as a visit to the dentist, was recorded.

It was impossible to get several subjects to undergo this long, rigidly conditioned series of tests during the same months. Subjects had to be taken when they could be had for several months without interruption, *every* day at the *same* hour. It was not easy to find normal women who could and would conform to these conditions, without compensation and without information as to what the object of the work might be. The tests therefore extend over four separate series of months.

The first series of tests (on subjects M1, F1 and F2) began on December 21, 1911, and ended March 30, 1912. One record was made daily for each subject in each test until March 3d. It was then thought that a more reliable measure of efficiency

on a given day could be obtained, and thereafter two trials daily were taken, the first at the same hour as previously, and the second just before retiring for the night. Thus after March 3d, each record is the average of *two* trials.

The second series of tests (on subject F3) began September 29, 1912, and ended January 7, 1913. Each daily record in each test for F3 is the average of *two* trials. The test for fatiguability (on subjects M1, F2 and F3) was also carried out during the same months in which the tests on F3 were made.

The third series of tests (on M2 and F4) began on April 19, 1913, and ended on June 12, 1913. Each record in each test for M2 and F4 is the average of *two* trials.

The fourth series of tests (on subject F6) began November 13, 1913, and ended February 5, 1914. Each record in each test for F6 is the average of *two* trials.

There were eight subjects, six women and two men.

F1 was a woman 23 years of age, a student and a teacher of music. She was entirely naïve to the experiment, having no idea of the purpose involved. This subject never suffered at physiological periods.

F2 was a woman 25 years of age, a university graduate student. She knew the purpose of the experiment, but had no preconceived notion as to how any particular test would be affected. This subject occasionally experienced some pain for a few hours on the first day of the period, and it may be added here that this was the case on January 5th and February 1st, but not on the other first days included in this record.

F3 was a woman 24 years of age, a college student whose profession was teaching. She, like F1, was entirely naïve to the experiment, having no idea whatever of the purpose of the tests. This subject very rarely experienced discomfort at physiological periods, and did not at any period included in this report.

F4 was a woman 36 years of age, the mother of two children. This subject was also a teacher, and as such had led a professional life for ten years before her marriage. She knew the purpose of the experiment, and had the preconceived idea that she would prove to be *less steady* during menstruation. She had no preconceived notion as to the outcome of the other tests.

F4 regularly experienced an attack of neuritis just before each period, due to a pathological condition of which she was cognizant, and frequently had a premonitory headache. During the period itself this subject did not suffer.

F5 was a woman 24 years of age, the mother of one child. She was a college graduate, but had never led a professional life. She knew the purpose of the experiment, but had no preconceived idea as to the outcome of the test. This subject took part only in the experiment on typewriting. She never suffered at menstrual periods.

F6 was a woman 45 years of age. This subject had had one child. She was a university graduate, and before her marriage she had been a teacher. She knew the purpose of the experiment, but had no preconceived ideas as to the probable outcome of any of the tests. She was passing through the climacteric, and to this fact is due the irregularity of occurrence and duration in the critical periods included in her record. This subject reported "no pain" at every one of the three periods included. She reported "very tired" on the first day of the first period, and on the fourth day of the third period, the same report being also made on days when the subject was not menstruating.

Two men took the tests in exactly the same way as the women subjects, thus yielding a control record. M1 was 31 years of age, and M2 was 37 years of age. Both were trained psychologists, and both led professional lives. Both were in excellent mental and physical health.

These women (except for the recurrence of neuritis in the case of F4) presented conditions of normal menstrual health, and all were in excellent mental health. None of them (except F4) experienced headaches or other nervous symptoms at periods, and they were not accustomed to remit work or make changes in their usual programmes of occupation. F2 and F3 were sisters. F1, F4, F5 and F6 were not related to them nor to each other in any way. The exact occurrence of physiological periods was indicated by placing a star (*) on the records taken on the days comprising each period. For F1, F2 and F3 the period presumably affected was five days in duration; for F4, sometimes five and sometimes four days; for F5, six days; for F6, sometimes five and sometimes three days.

It is regrettable that daily records could not have been taken on a much greater number of subjects (both men and women). The intensive work with eight subjects is, however, supported and extended by similar experiments made on seventeen women, each of these subjects being tested on every third day for a period of thirty days. This additional work will be reported in a subsequent section of this monograph. The intensive study of the eight subjects who were tested daily is based on about 4,500 precise observations. The experiments were performed with the following questions in mind:

(1) Will careful and exact measurement reveal a periodic mental and motor inefficiency in normal women?

(2) If inefficiency be found, is it a function of physical suffering, or of profound psychological change, occurring independently of pain?

(3) If inefficiency be found, is it characteristic of the whole period, or only of a part of it?

(4) Is there greater or less variability of performance on days presumably affected?

(5) Is it possible to discern a period of regularly recurring maximum efficiency in each month?

(6) Is it possible to find, by methods of precision, the cycle referred to by Ellis and others?

(7) Can any relation be established between the curves platted for pulse-rate, blood pressure, temperature, etc., and the curves of a daily mental or motor performance extending over several months?

III

MOTOR TESTS
SPEED OF VOLUNTARY MOVEMENT

The Tapping Test (Part 1)

This is a familiar test, which has been used to study a great variety of factors, such as individual differences, fatigue, effects of drugs, insanity, etc. For a complete list of investigations carried out by means of this test, see Whipple's "Manual of Mental and Physical Tests," p. 114.

G. S. Hall[1] says of this test, "The greatest number of taps that can be made in a given brief time interval is an important determination . . . for accessory muscular control. . . . This measurement is very important, and marks one of the factors of motor ability. How rapidly two like simple volitional contractions can follow each other is perhaps the best index we have of will time."

The apparatus used for this experiment was the very familiar motor-board employed in the Columbia laboratory. The individual sat before this board, which was placed on a table, and tapped 400 times at maximal speed, on a brass plate, with a small brass rod, each tap being registered by an electric counter. The subject began tapping at a signal from the operator, and the time of performance was recorded by the operator with a stop watch, in fifths of a second. Thus the amount of performance remained constant, while the time varied.

Whipple[2] points out that "The use of an electric counter such as some investigators have employed—gives no indication of changes in speed during the trial." Also that the electric counter will miss a quick tap, and is therefore not absolutely reliable. In the present case no attempt was made to register anything except the gross speed of performing 400 taps, with the right

[1] G. Stanley Hall, *op. cit.*, p. 142.
[2] Whipple, Manual of Mental and Physical Tests, p. 106.

hand. The apparatus seemed to be perfectly satisfactory for this purpose, and failure to record a tap was never observed.

If the will power of an individual were remitted during an affected period, if muscular tonus were lowered, or the general motor ability decreased, this test would be expected to reveal the condition. Hollingworth[3] found it to be sensitive to so small an influence as 1 to 2 grains of caffein.

The complete daily records of the seven subjects are given in Table I, and require no comment.

Table II gives the daily records converted into averages of five-day periods each. The five-day periods are determined in the case of the women by counting backward and forward from physiological periods. Thus a few "blocks" are formed by four or six days, instead of five, since the number of days between periods is not always exactly divisible by five. In the case of M1 and M2, the five-day blocks are determined by beginning to average parallel to the records of F1 and of F4, respectively. Thus are yielded two controls composed of five-day blocks arbitrarily determined, from records made by human beings not subject to the phenomenon in question.

Examining the contents of Table II, we find that the records marked (*) form a consistent part of an ordinary practice curve. They show no tendency to rise above the records preceding, and thus to cause "breaks" of inefficiency in the down-sweeping practice curve. The record made by F1 on January 12-16 is an exception, however, this being 53.1* as compared with 50.9 and 51.2 for the two five-day periods preceding. F1 shows no such tendency in the other two critical periods included in her record, and F2, F3, F4 and F6 show no such tendency whatever. The control records also reveal averages which revert to a level of efficiency attained ten and fifteen days previously.

The mean variation (M. V.) of records made during periods presumably affected shows no uniform tendency. It may be observed in passing that the M. V.'s for this test are very small, rendering the figures exceedingly reliable.

Table III gives the results of treating the figures as follows: The records are averaged in fives as in Table II, except that only three groups of periods are considered, i. e., the five days

[3] H. L. Hollingworth, *op. cit.*, p. 43.

preceding, the five days during, and the five days following the critical period. Also, in Table III the women are treated separately, and the control records are averaged in periods *exactly corresponding* to those of the subject under special consideration, which was not done in Table II. The averages for the days before and after are then averaged, and the result compared with the average of the five days during, to see if the latter will yield a uniformly poorer or better average. The control records are treated in exactly the same way. In this manner is obtained a *standard of efficiency* by which to measure the ability of the critical period, eliminating the factor of practice.

This method of averaging preceding and following periods for purposes of comparison with a middle period to determine relative efficiency assumes a uniform or nearly uniform rate of improvement in the practice curve. And the frequency with which the average of the periods preceding and following corresponds exactly or nearly to that of the middle period seems to indicate that the rate of improvement, in this test at least, does tend to be uniform. Thus if the middle period were subject to impaired efficiency, it would appear that averages computed in the way described should reveal the fact.

Furthermore, Table III shows the average for four days of each critical period, excluding the first day, which has been said to be subject to greater impairment than the other days, and the record of the first day is given separately.

The case of F1 is first considered in Table III. On the first month this subject, as already remarked, made a poor record at the critical period, the figures being 53.1* as compared with 49.9, the standard of efficiency for that period. On the other two months included, the averages compared are found to be identical, indicating no influence whatever.

Scrutinizing the record of F2, it is seen that the averages to be compared are identical for three out of the four months included, indicating no influence whatever. On the second month the average for the critical period is 38.5* as compared with 39.4, the standard of efficiency, but the difference is within the M. V., so no advantage is indicated for days presumably affected.

The records of F3, F4 and F6 confirm the records of the other subjects. No influence of periodicity is indicated by the

average of performance. The very slight differences between the critical periods and the standards of efficiency fall in all cases well within the M. V. It must be said that these observations reveal no influence whatever on the average of performance.

Table III fails to demonstrate greater impairment on the first day of menstruation. In fact the figures suggest an increased briskness of performance on the first day in the records of all the women. In eleven instances out of the fifteen herein observed, the first day's record exceeds in speed the average, not only of the five days in which it is included, but of the period *following*. The amount of the apparently increased briskness is, however, very slight, and it is without doubt due solely to chance.

F2 experienced some physical pain on the first day of the first two periods, and none on the last two. This fact seems to have made no difference in the records.

As Hall remarks, "This process is always very rapidly fatiguing." Although no attempt was made to measure the difference in time between the first 200 and the last 200 taps, it might be supposed that if the tendency to fatigue were considerably greater during an affected period, the total time of performance would be measurably increased by the last 200 taps. This does not appear.

When curves are platted from Tables I and II, and are examined with a view to determining whether a regularly recurring period of maximum efficiency is discernible within each month, we find no clear result. There does seem to be in this test a tendency to a rhythm of efficiency, but this tendency is just as clearly present in the case of M1 and M2 as in the case of F1, F2, F3, F4 and F6, and on the basis of this experiment is, therefore, not attributable to the phenomenon of menstruation as a cause. It is not possible to say on the basis of these experiments whether the appearance of rhythm is accidental, especially since it is by no means clearly defined, but only vaguely suggested. The period of maximum efficiency (speediest performance) seems to fall just before and on the first day of the period in the case of the women subjects. At any rate the figures do not support the statement of expert opinion that fatiguability is much greater, will power weaker, and motor energy dimin-

ished at this time. It will be well to point out in this connection that in any curve of work there will always be fluctuations which are of a more or less accidental nature, and which are not at all a matter of a fundamental "cycle" of efficiency. In the very nature of the case, regardless of concomitant phenomena, there will be high points and low points on the curve, within each month or within any limits of time we may wish to specify.[4]

TABLE I

DAILY RECORD OF THE TAPPING TEST (PART I)

Time required (in seconds) to make 400 taps, by individuals M1, F1, F2, F3, M2, F4 and F6. Menstrual periods are denoted by stars (*).

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913–Feb. 5, 1914
Day	M1	F1	F2	F3	M2	F4	F6
1	46.6	56.6	48.8	59.8	54.5	57.7	77.5
2	42.2	54.4	45.8	52.5	49.0	60.0	63.1
3	45.0	51.4	45.2	49.1	50.6	60.0	63.3
4	47.6	51.2	47.0	44.8	55.3	58.5	56.8
5	47.0	49.0	44.6*	57.0	51.5	59.0	58.2
6	49.8	48.6	46.0*	66.6	50.0	57.5	58.8
7	47.5	51.2	46.8*	55.6	50.8	57.3	56.4
8	46.2	51.6	46.2*	56.8	55.5	52.3	57.0
9	44.6	52.0	45.6*	55.0	53.2	56.5	57.1
10	43.0	51.0	46.6	56.0	55.5	54.5	60.2
11	43.8	50.0	44.0	49.4	53.2	52.5	57.2
12	44.2	51.0*	45.2	59.8	56.1	54.2	abs.
13	42.4	52.8*	46.0	50.2	54.3	54.1	58.7
14	41.0	56.8*	42.8	48.7	54.0	49.7	56.5*
15	43.4	54.8*	45.6	51.7	53.5	50.0	55.4*
16	40.8	50.0*	46.0	47.3	52.0	47.9	59.3*
17	40.8	50.4	43.2	52.0	52.0	47.7*	59.6*
18	41.8	46.4	42.4	50.1	53.4	48.4*	57.6*
19	42.4	50.0	40.0	45.6	51.0	47.5*	59.2
20	42.0	47.0	abs.	50.4	55.2	50.1*	58.0
21	40.4	49.0	abs.	45.7	53.1	49.5	60.5
22	41.6	49.8	41.2	46.0	51.7	51.5	58.7
23	41.6	49.2	38.4	45.0	54.4	49.8	62.0
24	43.6	48.2	39.2	41.7	52.3	46.8	62.5
25	42.2	48.4	40.0	40.6	54.4	45.2	61.4
26	40.0	48.6	40.2	39.9*	53.7	46.7	59.2
27	41.6	53.0	39.0	41.9*	54.9	45.7	58.9
28	42.0	47.8	38.2	42.0*	51.7	48.1	56.6
29	41.8	45.0	40.0	42.8*	53.0	48.0	59.1
30	42.0	44.8	39.6	41.5*	50.0	47.5	59.2
31	40.0	43.4	39.2	39.4	47.9	46.3	58.3
32	40.2	43.8	37.4*	39.9	49.7	46.1	61.3
33	38.6	43.4	38.6*	39.5	50.0	46.8	55.1
34	43.8	45.0	36.4*	42.0	49.0	44.8	60.1
35	40.0	47.6	40.8*	41.9	48.3	44.4	59.5

[4] E. L. Thorndike, The Curve of Work, *Psych. Rev.*, May, 1912, pp. 168-169.

TABLE I—(Continued)

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913–Feb. 5 ,1914
Day	M1	F1	F2	F3	M2	F4	F6
36	40.4	44.6	39.2*	44.7	47.5	44.7	56.8
37	37.5	44.6	40.8	39.1	49.3	46.8	58.7
38	39.6	44.8	39.8	39.8	47.9	45.2	59.3
39	38.8	43.4	38.2	43.2	50.9	47.4	58.9
40	38.8	42.6*	42.0	39.0	50.2	45.7	58.9
41	39.2	43.2*	37.2	39.5	48.0	48.1	60.7
42	39.0	47.4*	38.0	40.0	48.8	47.0	54.9
43	40.6	43.2*	39.2	40.6	46.8	46.9	51.3
44	37.6	44.4*	37.0	41.9	46.0	45.6*	59.8
45	36.2	42.4	37.8	46.0	46.3	45.2*	49.7
46	39.8	43.8	36.6	44.1	47.3	45.5*	53.6
47	36.4	42.6	37.6	42.2	49.1	46.5*	abs.
48	39.0	43.8	39.4	41.9	49.7	46.6*	abs.
49	37.8	43.8	39.4	40.5	50.0	46.4	abs.
50	39.4	43.0	36.4	43.7	47.6	45.2	abs.
51	40.6	44.2	35.0	40.3	47.8	47.0	52.8
52	39.6	44.4	36.0	38.1	44.0	44.5	53.9
53	38.2	46.0	36.0	38.5	47.0	46.5	57.1
54	37.8	41.8	35.4	37.1*	43.4	43.6	55.5
55	41.0	47.0	35.0	40.4*	43.0	44.2	54.8
56	39.0	45.4	39.6	41.0*	....	....	55.0
57	38.4	44.6	37.0*	44.3*	....	....	54.3
58	38.8	45.0	37.6*	40.0*	....	....	54.2
59	36.2	45.2	36.8*	38.8	....	....	abs.
60	36.6	44.2	36.4*	39.7	....	....	56.3*
61	36.0	44.8	35.4*	40.8	....	....	54.8*
62	37.4	43.2	38.8	36.8	....	....	50.8*
63	38.8	43.0	36.6	40.3	....	....	54.5
64	39.1	43.1	35.9	39.1	....	....	54.1
65	37.9	45.1	36.6	36.9	....	....	55.2
66	40.2	45.1	37.0	37.4	....	....	53.8
67	36.5	44.6	36.4	39.6	....	....	57.2
68	39.5	42.0	37.2	40.6	....	....	53.5
69	40.0	43.1	37.7	41.6	....	....	55.7
70	40.8	41.0	36.8	41.5	....	....	56.7
71	41.0	39.4	37.3	42.5	....	....	52.1
72	39.2	43.1	35.5	38.7	....	....	53.1
73	39.5	40.8*	36.9	39.9	....	....	abs.
74	39.7	42.0*	36.1	39.6	....	....	54.8
75	38.4	41.1*	37.3	40.9	....	....	53.3
76	39.6	41.3*	36.1	40.8	....	....	52.7
77	38.7	41.5*	36.6	38.6	....	....	54.5
78	38.2	39.2	35.4	42.4	....	....	53.9
79	40.2	40.8	37.1	38.5	....	....	53.9
80	39.3	42.4	36.2	42.3	....	....	52.8*
81	38.7	42.8	37.8	42.1	....	....	55.3*
82	37.7	39.7	36.2	41.2	....	....	50.9*
83	38.0	41.7	36.6*	41.3	....	....	54.1*
84	36.3	38.2	36.2*	38.6	....	....	55.7*
85	38.9	40.6	37.3*	39.7	....	....	50.4
86	38.2	37.9	37.4*	38.3	....	....	....

TABLE I—(Continued)

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913–Feb. 5, 1914
Day	M1	F1	F2	F3	M2	F4	F6
87	39.4	38.4	36.9*	39.0*	....	....	....
88	37.7	41.9	37.9	40.8*	....	....	....
89	37.7	40.1	36.7	37.8*	....	....	....
90	36.2	45.6	37.0	40.8*	....	....	....
91	....	....	....	40.0*	....	....	....
92	....	....	....	41.2	....	....	....
93	....	....	....	38.6	....	....	....
94	....	....	....	40.0	....	....	....
95	....	....	....	38.8	....	....	....
96	....	....	....	39.0	....	....	....
97	....	....	....	41.0	....	....	....
98	....	....	....	41.5	....	....	....
99	....	....	....	37.4	....	....	....
100	....	....	....	38.0	....	....	....
101	....	....	....	41.8	....	....	....

TABLE II

DAILY RECORDS OF THE TAPPING TEST, PART I (SEE TABLE I), CONVERTED INTO AVERAGES, OF 5-DAY PERIODS EACH

Five-day periods are determined by counting backward and forward from menstrual periods. Menstrual periods are indicated by stars (*).

1911–1912				1911–1912				1911–1912				1912–1913			
SUBJECT	M1			SUBJECT	F1			SUBJECT	F2			SUBJECT	F3		
Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %
Dec. 22–Jan. 6	46.3	2.1	4.5	Dec. 22–Jan. 6	50.9	1.7	3.3	Dec. 21–Dec. 24	46.7	1.2	2.6	Sept. 29–Oct. 3	52.6	4.6	8.7
Jan. 7– 11	45.0	1.5	3.2	Jan. 7– 11	51.2	.5	1.0	Jan. 5–Jan. 9	45.8*	.6	1.3	Oct. 4– 8	58.0	3.4	5.8
12– 16	42.4	1.2	2.7	12– 16	53.1*	2.2	4.1	10– 14	44.9	1.2	2.7	9– 13	51.9	3.1	5.9
17– 21	41.5	.7	1.7	17– 21	48.6	1.5	3.0	15– 19	43.4	1.9	4.3	14– 18	49.1	2.1	4.3
22– 26	41.8	.9	2.1	22– 26	48.8	.5	1.1	20– 21	Abs.	Abs.	Abs.	19– 23	43.8	2.1	4.8
27– 31	41.5	.6	1.4	27– 31	46.8	2.9	6.2	22– 26	39.8	.8	2.0	24– 28	41.6*	.7	1.7
Feb. 1–Feb. 5	40.6	1.3	3.2	Feb. 1–Feb. 4	44.9	1.1	2.5	27 31	39.2	.5	1.2	29–Nov. 2	40.5	1.1	2.7
6– 10	38.8	.5	1.2	5– 8	45.0	1.0	2.3	Feb. 1–Feb. 5	38.5*	1.3	3.3	Nov. 3–Nov. 7	41.2	2.2	5.3
11– 15	38.6	1.4	3.6	9– 13	44.2*	1.4	3.2	6– 10	39.6	1.5	3.8	8– 12	41.6	1.9	4.6
16– 20	38.6	1.2	3.2	14– 18	43.3	.6	1.4	11– 15	37.7	.7	2.0	13– 16	42.2	1.0	2.4
21– 25	39.1	.7	1.8	19– 23	44.1	1.3	3.0	16– 20	37.6	1.5	3.9	17– 20	40.2	1.9	4.7
25–Mar. 1	37.2	1.8	3.0	24– 28	45.4	.6	1.3	21– 25	36.4	1.3	3.5	21– 25	40.6*	1.7	4.2
Mar. 2– 6	38.7	.8	2.1	29–Mar. 4	43.7	.7	1.6	26–Mar. 1	36.6*	.6	1.6	26– 30	39.3	1.2	3.6
7– 11	39.6	1.1	2.6	Mar. 5– 8	43.9	1.2	2.6	Mar. 2– 6	36.9	.7	2.0	Dec. 1–Dec. 5	38.7	1.3	3.4
12– 16	39.3	.4	1.0	9– 12	41.7	1.2	2.9	7– 11	37.1	.4	1.0	6– 10	40.8	1.2	2.9
17– 21	39.0	.6	1.5	13– 17	41.3*	.3	.8	12– 16	36.4	.6	1.6	11– 14	39.8	.9	2.3
22– 26	37.8	.7	1.7	18– 22	40.9	1.3	3.1	17– 22	36.6	.6	1.7	15– 18	41.3	1.4	3.4
27– 30	37.8	.9	2.2	23– 27	39.4	1.4	3.7	23– 27	36.9*	.4	1.3	19– 23	39.8	1.1	2.8
				28– 30	42.5	2.0	4.7	28– 30	37.2	.5	1.3	24– 28	39.7*	1.0	2.5
												29–Jan. 2	39.5	.9	2.4
												Jan. 3– 7	40.0	1.7	4.3

TABLE II—(Continued)

1913				1913–1914							
Subject	M2			Subject	F4			Subject	F6		
Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %
April 19–April 22	52.4	2.6	5.0	April 19–April 22	59.1	1.0	1.7	Nov. 13–Nov. 15	67.9	6.3	9.3
23– 26	51.9	1.8	3.5	23– 26	56.5	2.1	2.7	16– 20	57.4	.8	1.4
27– 30	54.5	1.3	2.4	27– 30	54.4	1.1	2.0	21– 25	58.3	1.2	2.1
May 1–May 4	53.5	.7	1.3	May 1–May 4	50.4	1.8	3.5	26– 30	57.7*	1.4	2.4
5– 8	52.9	1.4	2.6	5– 8	48.4*	.8	1.6	Dec. 1–Dec. 5	59.7	1.3	2.2
9– 12	52.9	.9	1.7	9– 12	49.4	1.3	2.6	6– 10	59.7	1.8	3.0
13– 17	53.5	1.0	1.9	13– 17	46.7	.6	1.3	11– 15	58.6	1.3	2.2
18– 22	49.3	.7	1.4	18– 22	46.3	.7	1.5	16– 20	58.9	.9	1.5
23– 26	48.2	.6	1.2	23– 26	45.3	.8	1.8	21– 25	56.9	3.1	5.5
27– 31	48.9	1.3	2.7	27– 31	47.0	.6	1.3	26– 30	54.4	3.6	6.6
June 1–June 5	47.7	1.4	2.9	June 1–June 5	45.9*	.5	1.1	31–Jan. 4	54.6	1.7	3.1
6– 10	47.3	1.3	2.7	6– 10	45.9	.9	2.0	Jan. 5–Jan. 7	55.1	.3	0.5
11– 12	43.2	.2	0.5	11– 12	43.9	.3	0.7	8– 10	54.3	0.0	0.0
								11– 13	53.9*	2.1	3.9
								14– 16	54.6	.4	0.7
								17– 20	55.1	1.4	2.5
								21– 25	54.2	1.6	3.0
								26– 30	53.7	.5	1.0
								31–Feb. 4	53.8*	1.5	2.8
								Feb. 5.....	50.4	0.0	0.0

TABLE III

Tapping Test, Part I

Shows average performance for the 5 days preceding, the 5 days during, and the 5 days following each menstrual period. Shows also the average performance for 4 days of each menstrual period, excluding the first day, which is given separately. Shows also control records. Menstrual periods are indicated by stars (*).

Record of F1

	Subject	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month	F1	51.2	.5	1.0	53.1*	2.2	4.1	48.6	1.5	3.0	49.9	53.6*	2.2	4.1	51.0*
	F2 (control)	45.8	.8	1.8	45.1	.9	2.1	41.9†	1.2	2.9	43.9	45.1	1.2	2.2	45.2
	M1 (control)	45.0	1.5	3.2	42.4	1.2	2.7	41.5	.7	1.7	43.3	41.9	1.0	2.4	44.2
2nd month	F1	45.0	1.0	2.3	44.2*	1.4	3.2	43.3	.6	1.4	44.2	44.6*	1.5	3.3	42.6*
	F2 (control)	39.8	.8	2.1	38.7	1.5	3.9	38.2	1.0	2.6	39.0	37.9	.8	2.0	42.0
	M1 (control)	39.3	.9	2.2	39.0	.7	1.7	37.8	1.2	3.3	38.6	39.1	.8	2.0	38.8
3rd month	F1	41.7	1.2	2.9	41.3*	.3	.8	40.9	1.3	3.1	41.3	41.5*	.3	.7	40.8*
	F2 (control)	36.6	.4	1.1	36.9	.6	1.6	36.5	.7	2.0	36.6	36.5	.4	1.2	36.9
	M1 (control)	40.1	.6	1.6	39.2	.5	1.3	38.8	.7	1.9	39.4	39.1	.6	1.4	39.5

†Absent two days out of this period.

TABLE III—(Continued)

RECORD OF F2

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month	F2	46.7	1.2	2.6	45.8*	.6	1.3	44.9	1.2	2.7	45.8	46.1*	.4	.8	44.6*
	F1 (control)	53.4	2.1	3.9	50.5	1.3	2.7	52.1	1.9	3.7	52.8	50.8	1.2	2.3	49.0
	M1 (control)	45.7	1.7	3.6	47.0	1.3	2.8	42.9	.9	2.2	44.3	47.0	1.6	3.4	47.0
2nd month.	F2	39.2	.5	1.2	38.5*	1.3	3.3	39.6	1.5	3.8	39.4	38.8*	1.3	3.2	37.4*
	F1 (control)	46.8	2.9	6.2	44.9	1.1	2.5	43.7	.8	1.8	45.3	45.2	1.3	2.8	43.8
	M1 (control)	41.5	.6	1.4	40.6	1.3	3.2	38.8	.5	1.2	40.2	40.7	1.6	3.8	40.2
3rd month.	F2	36.4	1.3	3.5	36.6*	.6	1.6	36.9	.7	2.0	36.6	36.6*	.7	1.8	37.0*
	F1 (control)	45.1	1.3	3.0	44.8	.3	.6	43.9	1.0	2.2	44.5	44.8	.3	.6	44.6
	M1 (control)	39.1	.7	1.8	37.2	1.1	3.0	38.7	.8	2.1	38.9	36.9	1.0	2.6	38.4
4th month.	F2	36.6	.6	1.7	36.9*	.4	1.3	37.2	.5	1.3	36.9	36.9*	.4	1.1	36.6*
	F1 (control)	40.9	1.3	3.1	39.4	1.4	3.7	41.2	2.5	6.1	41.1	38.8	.9	2.4	41.7
	M1 (control)	38.8	.7	1.9	38.2	.8	2.1	37.2	.7	1.8	38.0	38.2	1.0	2.5	38.0

RECORD OF F3

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month	F3	43.8	2.1	4.8	41.6*	.7	1.7	40.5	1.1	2.7	42.1	42.1*	.4	.9	39.9*
2nd month.	F3	40.2	1.9	4.7	40.6*	1.7	4.2	39.3	1.2	3.1	39.8	41.4*	1.1	2.7	37.1*
3rd month.	F3	39.8	1.1	2.8	39.7*	1.0	2.8	39.5	.9	2.3	39.7	39.9*	1.0	2.5	39.0*

TABLE III—(Continued)

RECORD OF F4

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av.4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month	F4	50.4	1.8	3.6	48.4*	.8	1.6	49.4	1.3	2.6	49.9	48.7*	1.0	2.0	47.7*
	M2 (control)	53.5	.7	1.3	59.9	1.4	2.6	52.9	.9	1.7	53.2	53.2	1.5	2.8	52.0
2nd month	F4	47.0	.6	1.3	45.9*	.5	1.1	45.9	.9	1.9	46.5	46.0*	.6	1.3	45.6*
	M2 (control)	48.9	1.3	2.6	47.7	1.4	2.9	47.3	1.3	2.7	48.1	48.1	1.3	2.7	46.0

RECORD OF F6

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month	F6	58.3	1.2	2.0	57.7*	1.4	2.4	59.7	1.3	2.2	59.0	58.0*	1.5	2.6	56.5*
2nd month	F6	54.3	0.0	0.0	53.9*	2.1	3.9	54.6	.4	.7	54.4	52.8*	2.0	3.7	56.3*
3rd month	F6	53.7	.5	.9	53.8*	1.5	2.7	Not Completed	.....	.....	.....	54.0*	1.6	2.9	52.8*

Standard of efficiency=Standard by which efficiency of menstrual period is measured.

The Tapping Test (Part II)

In order to obtain a further and slightly different measure of voluntary speed, the time of performance for the first 300 taps in the experiment on fatiguability was computed and tabulated. (For description of method and apparatus see chapter on Motor Fatiguability.) Table IV gives the daily records for the three subjects (F2, F3, M1). Table V gives the records averaged in five-day "blocks," as in Table II under Part I of this test. Table VI shows the figures computed as in Table III, and with the same purpose, i. e., to compare the average of the critical period with a standard of efficiency; to examine the average performance of four critical days, excluding the first; and to determine whether the first day shows a remarkable impairment.

The results of this test are in agreement with those of Part I. In Table V the records marked (*) form part of an ordinary practice curve, revealing no inefficiency. Table VI shows the critical average to be always slightly better than the standard of efficiency, but the difference falls in all cases within the M. V., so no genuine advantage for critical periods is indicated. Four out of six first days show a performance superior not only to the average in which they are included, but to the average following.

The conclusion, therefore, is that in this test as in the other, no influence whatever on the average of performance is indicated for critical periods.

TABLE IV

THE TAPPING TEST. PART II (With Key)

Time required (in seconds) to make 300 taps, by individuals M1, F2 and F3. The menstrual periods are denoted by stars (*).

DATE	M1	F2	F3	DATE	M1	F2	F3
Sept. 29	40.4	40.4	64.0	Nov. 19	33.2	39.2	48.2
30	39.4	39.2	58.4	20	33.8	41.0	52.8
				21	30.4	38.4	47.2*
Oct. 1	39.4	38.2	55.4	22	30.0	41.4	53.8*
2	39.2	40.2	54.0	23	34.0	39.8	58.0*
3	43.8	48.2	73.2	24	31.2	41.2	52.6*
4	40.2	40.8	58.4	25	33.6	39.6	50.0*
5	37.0	38.2	56.2	26	34.2	40.2	52.4
6	36.6	43.6	58.8	27	35.8	39.6	51.4
7	32.2	38.2	60.2	28	34.0	34.0	48.0
8	37.6	36.4	55.2	29	30.4	37.8	51.8
9	31.0	40.0	56.2	30	32.6	42.6	55.4
10	35.8	33.6	59.4				
11	31.0	35.0	58.2	Dec. 1	30.0	40.0	48.6
12	32.8	36.0	58.2	2	29.8	41.4	42.2
13	34.8	36.8	62.4	3	31.8	37.8	48.2
14	33.2	33.2*	63.2	4	30.8	37.8	53.2
15	31.6	33.9*	63.4	5	31.2	35.8	50.4
16	33.2	39.2*	58.4	6	32.2	35.4*	47.8
17	33.8	37.2*	58.2	7	32.2	36.6*	52.2
18	30.6	35.2*	59.6	8	31.6	39.4*	56.8
19	32.6	39.2	64.2	9	32.8	40.0*	55.6
20	34.8	41.4	62.2	10	30.2	35.6*	56.6
21	32.8	38.0	62.8	11	29.6	45.0	45.2
22	33.8	36.0	60.6	12	31.2	40.2	49.6
23	31.8	35.8	62.8	13	38.4	40.4	61.6
24	33.6	38.2	63.2*	14	32.8	39.0	55.0
25	33.4	31.6	57.8*	15	30.0	42.2	62.4
26	34.0	39.8	58.8*	16	33.4	37.4	53.8
27	36.6	43.0	63.6*	17	31.6	36.6	53.0
28	35.8	39.2	63.2*	18	34.6	38.0	53.0
29	33.0	34.0	62.2	19	29.4	37.8	49.2
30	30.8	34.4	54.8	20	30.6	35.6	56.6
31	32.2	39.0	65.0	21	33.8	41.6	51.6
				22	33.8	43.8	51.4
Nov. 1	33.0	38.6	60.8	23	33.2	37.2	60.8
2	38.6	36.2	66.2	24	31.0	34.6	45.6*
3	33.8	39.4	73.2	25	32.6	31.0	56.8*
4	34.6	42.4	51.2	26	34.2	38.2	50.8*
5	33.4	39.0	48.4	27	28.6	34.4	58.6*
6	32.6	38.2	50.6	28	29.0	38.8	54.8*
7	33.2	34.6	52.4	29	32.2	34.0	54.2
8	31.0	38.4	49.4	30	30.2	34.2*	55.4
9	31.4	39.2	52.8	31	34.2	36.6*	50.0
10	31.8	39.4*	57.6				
11	31.4	36.4*	54.0	Jan. 1	30.0	34.2*	45.4
12	37.4	36.0*	53.4	2	30.2	33.8*	53.0
13	30.8	35.8*	53.2	3	28.8	36.4*	57.8
14	30.0	40.0*	47.6	4	34.6	40.2	57.8
15	30.6	37.8	60.6	5	32.6	37.0	60.0
16	35.8	38.6	53.2	6	31.0	37.0	54.6
17	30.2	39.6	60.2	7	30.8	35.8	55.0
18	29.4	38.2	55.6				

TABLE V

DAILY RECORDS OF THE TAPPING TEST, PART II (SEE TABLE IV), CONVERTED INTO AVERAGES, OF 5-DAY PERIODS EACH

Five-day periods are determined by counting backward and forward from menstrual periods. Menstrual periods are indicated by stars (*).

1912–1913				1912–1913				1912–1913			
SUBJECT	M1			SUBJECT	F2			SUBJECT	F3		
Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %
Sept. 29–Oct. 3	40.4	1.4	3.5	Sept. 29–Oct. 3	41.2	2.8	6.8	Sept. 29–Oct. 3	61.1	6.2	10.1
Oct. 4– 8	36.7	1.8	4.9	Oct. 4– 8	39.4	2.2	5.6	Oct. 4– 8	57.8	1.6	2.8
9– 13	33.1	1.8	5.4	9– 13	36.3	1.7	4.7	9– 13	58.9	1.6	2.7
14– 18	32.5	1.1	3.4	14– 18	35.7*	1.9	5.3	14– 18	60.6	2.2	3.6
19– 23	33.2	.9	2.7	19– 23	38.1	1.8	4.7	19– 23	62.5	.9	1.4
24– 28	34.7	1.2	3.5	24– 28	38.4	2.8	7.3	24– 28	61.3*	2.4	3.9
29–Nov. 2	33.9	2.2	6.5	29–Nov. 2	36.4	1.9	5.2	29–Nov. 2	61.8	3.2	5.2
Nov. 3– 7	33.5	.5	1.5	Nov. 3– 9	38.7	1.4	3.6	Nov. 3– 7	55.2	7.2	13.1
8– 12	32.6	1.9	5.9	10– 14	37.5*	1.7	4.5	8– 12	53.4	1.9	3.6
13– 17	31.5	1.7	5.4	15– 19	38.7	.6	1.6	13– 16	53.7	3.5	6.5
18– 22	31.4	1.7	5.4	20– 24	40.4	1.0	2.5	17– 20	54.2	3.7	6.8
23– 27	33.8	1.1	3.3	25– 29	38.2	1.9	5.0	21– 25	52.3*	3.0	5.7
28–Dec. 2	31.4	1.6	5.1	30–Dec. 5	39.2	2.1	5.4	26– 30	51.8	1.7	3.3
Dec. 3– 7	31.5	.5	1.6	Dec. 6– 10	37.4*	1.8	4.8	Dec. 1–Dec. 5	48.5	2.7	5.6
8– 12	31.1	.9	2.9	7– 15	41.2	1.7	4.1	6– 10	53.8	3.0	5.6
13– 17	33.2	2.2	6.6	16– 20	37.1	.8	2.2	11– 14	52.9	5.5	10.4
18– 22	32.4	1.9	5.8	21– 25	37.6	4.0	10.6	15– 18	55.6	3.5	6.3
23– 27	31.9	1.7	5.3	26– 29	36.4	2.2	6.0	19– 23	53.9	3.8	7.1
28–Jan. 1	31.1	1.7	5.5	30–Jan. 3	35.0*	1.2	3.4	24– 28	53.3*	4.1	7.6
Jan. 2– 7	31.6	1.6	5.1	Jan. 4– 7	37.5	1.4	3.7	29–Jan. 2	51.6	3.1	6.0
								Jan. 3– 7	57.0	1.8	3.2

TABLE VI

Tapping Test, Part II

SHOWS AVERAGE PERFORMANCE FOR THE 5 DAYS PRECEDING, THE 5 DAYS DURING, AND THE 5 DAYS FOLLOWING EACH MENSTRUAL PERIOD

Shows also the average performance for 4 days of each menstrual period, excluding the first day, which is given separately. Shows also control records. Menstrual periods are indicated by stars (*).

RECORD OF F2

	Subject	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month.	F2	36.3	1.7	4.7	35.7*	1.9	5.3	38.1	1.8	4.7	37.2	36.4*	1.8	4.9	33.2*
	F3 (control)	58.9	1.6	2.7	60.6	2.2	3.6	62.5	.9	1.4	60.7	59.9	1.8	3.0	63.2
	M1 (control)	33.1	1.8	5.4	32.5	1.1	3.3	33.2	.9	2.7	33.2	32.3	1.2	3.7	33.2
2nd month.	F2	38.7	1.4	3.6	37.5*	1.7	4.5	38.7	.6	1.6	38.7	37.1*	1.5	4.0	39.4*
	F3 (control)	53.1	2.4	4.5	55.5	4.2	7.6	50.7	1.6	3.2	51.9	52.0	1.8	3.5	57.6
	M1 (control)	32.5	.8	2.5	32.3	1.8	5.6	31.8	2.2	6.9	32.2	32.4	2.5	7.7	31.8
3rd month.	F2	39.2	2.1	5.4	37.4*	1.8	4.8	41.2	1.7	4.1	40.2	37.9*	1.8	4.7	35.4*
	F3 (control)	48.5	2.7	5.6	53.8	3.0	5.6	55.0	6.0	10.9	51.8	55.3	1.6	2.9	47.8
	M1 (control)	31.2	.6	1.9	31.8	.7	2.2	32.4	2.2	6.8	31.8	31.5	.9	2.9	32.2

TABLE VI—(Continued)

RECORD OF F3

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month .	F3.....	62.5	.9	1.4	61.3*	2.4	3.9	61.8	3.2	5.2	62.1	60.9*	2.6	4.3	63.2*
	F2 (control)....	38.1	1.8	4.7	38.4	2.8	7.3	36.4	1.9	5.2	37.3	38.4	3.4	8.8	38.2
	M1 (control)...	33.2	.9	2.7	34.7	1.2	3.4	33.9	2.2	6.5	33.6	34.9	1.3	3.7	33.6
2nd month.	F3.....	54.2	3.7	6.8	52.3*	3.0	5.7	51.8	1.7	3.3	53.0	53.6*	2.3	4.3	47.2*
	F2 (control)....	39.3	.8	2.0	40.1	1.0	2.5	38.8	2.2	5.7	39.1	40.5	.8	2.0	38.4
	M1 (control)...	32.5	2.2	6.8	31.8	1.8	5.6	33.4	1.6	4.8	33.0	32.2	1.5	4.6	30.4
3rd month.	F3.....	53.9	3.8	7.1	53.3*	4.1	7.7	51.6	3.1	6.0	52.8	55.3*	2.5	4.5	45.6*
	F2 (control)....	39.2	2.8	7.1	35.4	2.4	6.8	34.6	.8	2.3	36.9	35.6	2.9	8.1	34.6
	M1 (control)...	32.2	2.0	6.2	31.1	1.8	5.8	31.4	1.5	4.8	31.8	31.1	4.9	15.8	31.0

Standard of Efficiency=Standard by which efficiency of menstrual period is measured.

IV

STEADINESS

This test is fully discussed in Whipple's "Manual of Mental and Physical Tests." It was carried out in the present instance exactly as described by Hollingworth[1] in his recent monograph. The subject, standing, was required to hold at arm's length and unsupported, a brass rod, 2.5 mm. in diameter, in a hole 6 mm. in diameter, which was formed in a brass plate. The time in this test remained constant, the subject being required to hold the rod for 30 seconds, making as few contacts as possible. Each contact was registered by an automatic electric counter. A measure of the involuntary movements of the right arm in a horizontal plane was thus obtained. Any increase in nervousness would, presumably, be apparent in the number of involuntary contacts registered.

The complete daily records of the seven subjects are found in Table VII. In the case of F3 and F6 the fraction (always .5) was retained when averaging the two daily records; in the case of the other subjects it was dropped. This slight difference in treatment was simply incidental to the fact that the records were treated on different occasions. These records converted into averages as described in this paper in connection with the tapping test, are given in Table VIII. The variability of these averages is so great as to render them very unreliable, the M. V. being in a majority of cases above 20 per cent, and often reaching as high as 45 per cent. Hence any conclusions drawn from these records cannot bear great weight. The test is very apt to be affected by purely external and accidental factors, such as taking a breath, coughing, hearing a noise.

According to expert opinion, as already quoted in this paper, we should expect to find greatly increased agitation at the critical periods in the case of the women subjects. An examination of the figures as they stand does not support this opinion.

[1] H. L. Hollingworth, *op. cit.*, p. 44.

A table similar to Table III under the tapping test was not compiled for steadiness, partly because the great variability of the averages would make such a table of little value, and partly because, owing to circumstances connected with starting the test, the records are somewhat irregular at the beginning. (See Table VII.)

When curves are platted from Tables VII and VIII, and are examined to determine whether a cycle of efficiency is discernible, it appears that there is no definite suggestion of such a cycle. It is true that in a practice curve of this kind there must always be fluctuations which are of a more or less accidental nature, and which are not at all a matter of a fundamental "cycle" of efficiency. In the very nature of the case, regardless of concomitant phenomena, there will be high and low points on the curve, within each month or within any limits of time we may wish to specify.

The pain suffered by F2 for a few hours on the first two first days seems to have had no characteristic effect.

On the whole the only statement that may be made with certainty on the basis of the steadiness test is, that it does not indicate increased agitation at menstrual periods.

TABLE VII

DAILY RECORD OF THE STEADINESS TEST

Number of involuntary contacts made in 30 seconds by individuals M1, F1, F2, F3, M2, F4 and F6. The menstrual periods are denoted by stars (*).

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913–Feb. 5, 1914
Day	M1	F1	F2	F3	M2	F4	F6
1	..	..	19*	44.5	6	22	37.0
2	..	..	23*	43.5	10	19	38.0
3	..	..	10*	32.5	12	20	44.5
4	..	..	12*	40.0	20	17	48.5
5	40	..	14*	26.5	12	24	64.5
6	30	..	8	16.0	9	30	58.5
7	21	..	23	20.0	16	35	63.5
8	18	24*	19	26.0	17	20	52.0
9	19	28*	42	11.5	15	15	57.0
10	21	43*	10	18.5	20	15	60.0
11	25	30*	9	18.5	7	12	54.5
12	20	17*	7	14.0	13	8	Abs.
13	24	13	16	10.0	9	5	55.5
14	15	44	25	14.0	12	6	55.0*
15	14	18	21	12.0	11	15	63.5*
16	20	19	Abs.	15.5	9	11	54.0*
17	48	22	Abs.	19.0	2	17*	55.5*
18	17	32	11	8.5	5	6*	55.0*
19	13	38	25	9.0	8	4*	53.0
20	25	40	14	15.0	5	3*	61.0

TABLE VII—(Continued)

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913 Feb. 5, 1914
Day	M1	F1	F2	F3	M2	F4	F6
21	14	23	22	9.5	9	10	61.0
22	13	40	23	8.0	2	5	60.0
23	12	49	26	10.5	5	1	44.0
24	18	31	13	14.0	3	10	58.5
25	24	54	15	11.0	7	6	53.5
26	14	41	20	4.5*	4	5	65.5
27	16	32	11	7.5*	4	7	57.5
28	15	40	8*	7.0*	4	5	50.0
29	12	40	11*	10.0*	10	1	57.0
30	8	25	17*	7.0*	3	9	63.5
31	13	25	17*	10.5	2	5	56.0
32	21	35	18*	8.5	3	4	53.5
33	12	39	15	6.5	8	7	57.0
34	3	15	32	9.5	8	6	55.5
35	16	32	23	4.5	5	5	54.5
36	11	25*	11	10.0	10	14	60.0
37	10	21*	27	11.0	9	3	52.5
38	11	34*	14	10.5	6	6	54.0
39	9	39*	21	9.5	7	7	61.0
40	8	38*	34	16.5	8	2	54.0
41	18	40	19	9.0	11	9	50.5
42	10	16	25	8.0	3	5	58.0
43	3	15	12	11.0	5	2	55.5
44	11	39	18	16.5	4	4*	55.0
45	15	33	26	7.0	5	1*	60.0
46	15	15	26	13.0	4	4*	65.0
47	9	17	15	4.0	7	4*	Abs.
48	3	21	20	12.5	5	2*	Abs.
49	6	25	12	5.0	4	7	Abs.
50	12	19	25	11.0	5	1	Abs.
51	6	17	19	6.0	3	3	55.5
52	8	28	18	20.0	7	2	65.0
53	2	17	14*	7.0	3	2	65.0
54	3	24	10*	5.0*	3	2	64.5
55	10	31	10*	5.0*	6	5	55.5
56	7	25	15*	7.0*	..	..	58.0
57	7	30	20*	5.0*	..	..	55.5
58	2	30	18	7.5*	..	..	61.0
59	8	11	13	9.5	..	..	Abs.
60	11	27	17	6.0	..	..	55.5*
61	12	30	10	7.0	..	..	61.5*
62	4	27	18	7.0	..	..	51.5*
63	9	19	17	7.0	..	..	58.5
64	3	18	8	11.0	..	..	56.0
65	10	19	12	5.5	..	..	57.5
66	11	21	10	7.5	..	..	53.5
67	3	14	20	7.0	..	..	55.5
68	6	8	12	11.5	..	..	54.0
69	9	20*	14	4.5	..	..	61.5
70	8	21*	11	11.5	..	..	51.0
71	9	21*	12	6.0	..	..	58.5
72	5	20*	10	10.5	..	..	59.0
73	7	16*	18	5.5	..	..	Abs.

TABLE VII—(Continued)

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913–Feb. 5, 1914
Day	M1	F1	F2	F3	M2	F4	F6
74	7	15	11	9.0	..	..	56.0
75	7	13	10	3.0	..	..	61.5
76	9	8	12	7.5	..	..	51.0
77	3	21	16	7.5	..	..	60.0
78	8	10	16	9.0	..	..	61.5
79	7	13	9*	12.0	..	..	57.5
80	3	9	4*	6.0	..	..	55.0*
81	4	7	8*	6.5	..	..	55.5*
82	8	12	11*	6.0	..	..	51.5*
83	9	5	8*	12.5	..	..	59.5*
84	8	4	13	12.5	..	..	53.0*
85	7	23	10	8.0	..	..	51.0
86	1	28	4	9.5	..	..	....
87	..	..	..	8.0*	..	..	....
88	..	..	..	9.5*	..	..	....
89	..	..	..	14.5*	..	..	....
90	..	..	..	7.5*	..	..	....
91	..	..	..	4.5*	..	..	....
92	..	..	..	8.0	..	..	....
93	..	..	..	9.5	..	..	....
94	..	..	..	7.5	..	..	....
95	..	..	..	9.5	..	..	....
96	..	..	..	10.0	..	..	....
97	..	..	..	12.0	..	..	....
98	..	..	..	9.0	..	..	....
99	..	..	..	7.0	..	..	....
100	..	..	..	7.5	..	..	....
101	..	..	..	11.5	..	..	....

TABLE VIII

DAILY RECORDS OF THE STEADINESS TEST (SEE TABLE VII) CONVERTED INTO AVERAGES OF 5-DAY PERIODS EACH.

Five=day periods are determined by counting backward and forward from menstrual periods. Menstrual periods are indicated by stars (*).

STEADINESS TEST

1911–1912				1911–1912				1911–1912				1912–1913			
SUBJECT	M1			SUBJECT	F1			SUBJECT	F2			SUBJECT	F3		
Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %
Jan. 9–Jan. 11	30.3	6.4	21.2	Jan. 12–Jan. 16	28.4*	6.4	22.5	Jan. 5–Jan. 9	16.0*	5.0	31.0	Sept. 29–Oct. 3	37.4	6.3	16.8
12– 16	20.6	1.9	9.2	17– 21	29.2	11.6	39.7	10– 14	20.0	9.6	48.0	Oct. 4– 8	18.4	3.7	20.5
17– 21	24.2	9.4	38.8	22– 26	34.6	5.6	16.2	15– 19	15.6	6.1	39.1	9– 13	13.7	2.2	16.0
22– 26	16.4	3.6	22.0	27– 31	39.4	10.6	26.9	20– 21	Abs.	Abs.	Abs.	14– 18	13.4	3.5	26.1
27– 31	16.8	3.4	20.2	Feb. 1–Feb. 4	32.5	7.5	23.1	22– 26	19.0	5.2	27.4	19– 23	10.6	1.3	12.2
Feb. 1–Feb. 5	13.8	3.4	24.6	5– 8	30.2	7.7	25.5	27– 31	17.0	4.8	28.2	24– 28	7.2*	1.2	16.6
6– 10	10.4	3.2	30.8	9– 13	31.2*	6.8	21.8	Feb. 1–Feb. 5	14.2*	3.8	26.8	29–Nov. 2	7.9	1.9	24.5
11– 15	11.2	2.6	23.2	14– 18	28.6	10.4	36.4	6– 10	21.6	6.8	31.5	Nov. 3– 7	11.5	2.0	17.4
16– 20	10.6	3.6	34.0	19– 23	19.4	2.8	14.4	11– 15	22.6	5.6	24.8	8– 12	10.3	2.8	27.2
21– 25	7.4	2.4	32.4	24– 28	23.4	5.2	22.2	16– 20	19.4	5.2	26.8	13– 16	8.6	4.1	47.7
26–Mar. 1	6.8	2.4	35.3	29–Mar. 4	24.6	5.2	21.1	21– 25	18.8	3.0	15.9	17– 20	11.0	4.5	41.0
Mar. 2– 6	7.4	3.6	48.6	Mar. 5– 8	23.5	5.0	21.3	26–Mar. 1	13.8*	3.0	21.7	21– 25	5.9*	1.1	18.6
7– 11	7.2	3.4	47.2	9– 12	15.5	4.5	29.0	Mar. 2– 6	15.2	3.0	19.7	26– 30	7.3	.9	12.3
12– 16	7.4	1.6	21.6	13– 17	20.2*	1.8	8.9	7– 11	13.4	4.0	29.9	Dec. 1–Dec. 5	8.5	2.2	25.9
17– 21	6.6	1.2	18.2	18– 22	13.4	3.6	26.9	12– 16	11.8	1.0	8.5	6– 10	7.6	2.7	27.2
22– 26	6.0	2.0	33.3	23– 27	9.2	2.6	28.3	17– 22	16.6	3.5	21.1	11– 14	6.8	1.9	27.9
27– 30	6.1	2.7	44.3	28– 30	18.3	9.6	52.5	23– 27	8.0*	1.6	20.0	15– 18	8.4	2.1	25.0
								28– 30	9.0	3.3	30.7	19– 23	9.7	2.2	22.6
												24– 28	8.8*	2.6	29.5
												29–Jan. 2	8.9	.9	10.0
												Jan. 3– 7	9.4	1.9	20.1

TABLE VIII—(Continued)

1913				1913–1914							
Subject		M2			Subject		F4			Subject		F6		
Date		Av. of 5 days	M. V. Sec.	M. V. %	Date		Av. of 5 days	M. V. Sec.	M. V. %	Date		Av. of 5 days	M. V. Sec.	M. V. %
April 19–	April 22	12.0	4.0	33.3	April 19–	April 22	19.5	1.5	7.7	Nov. 13–	Nov. 15	39.8	3.1	7.8
23–	26	13.5	3.0	22.2	23–	26	32.2	6.2	19.2	Nov. 16–	20	57.4	5.7	10.0
27–	30	13.7	3.7	22.9	27–	30	12.5	2.5	20.0	21–	25	56.8	1.8	3.2
May 1–	May 4	10.2	1.2	10.0	May 1–	May 4	9.3	3.7	39.7	26–	30	56.6*	2.9	5.1
5–	8	5.0	1.5	30.0	5–	8	7.5*	5.0	66.6	Dec. 1–	Dec. 5	56.0	5.8	10.0
9–	12	4.7	2.2	46.5	9–	12	6.5	3.5	59.0	6–	10	57.0	4.2	7.4
13–	17	5.8	2.2	37.9	13–	17	4.8	1.4	29.2	11–	15	57.4	2.4	4.2
18–	22	4.8	2.6	54.0	18–	22	6.2	1.4	22.5	16–	20	55.3	1.9	3.6
23–	26	7.5	2.0	26.7	23–	26	7.0	3.5	50.0	21–	25	55.8	2.6	4.7
27–	31	6.8	2.2	32.4	27–	31	5.0	2.4	48.0	26–	30	60.0	3.3	5.5
June 1–	June 5	5.0	.8	16.0	June 1–	June 5	3.0*	1.2	40.0	31–	Jan. 4	61.8	4.2	6.8
6–	10	4.4	1.2	27.3	6–	10	3.0	1.8	60.0	Jan. 5–	Jan. 7	59.3	5.1	8.6
11–	12	4.5	1.5	33.3	11–	12	3.5	1.5	43.0	8–	10	58.3	2.7	4.6
									..	11–	13	56.2*	3.6	6.4
										14–	16	57.3	.9	1.6
										17–	20	56.1	2.7	4.8
										21–	25	56.1	2.6	4.6
										26–	30	58.3	3.2	5.5
										31–	Feb. 4	54.9*	2.1	3.8
										Feb. 5.....		51.0	0.0	0.0

V

MOTOR FATIGUABILITY

It was desired to obtain a measure of fatiguability in order to gain further evidence regarding motor efficiency at critical periods. It has been seen that the average of performance in the case of voluntary speed of movement is unaffected by menstruation, when the amount of work done is 400 taps with the stylus. This would lead us to suspect that fatiguability is not greater for critical periods. For if fatiguability were greater then, there would undoubtedly be a measurable decrease in speed on the last 200 taps, and this would lower the total speed of performance at critical periods. However, this inference cannot be regarded as precise evidence, because (1) the amount of work done (400 taps) may not have been sufficient to produce a great enough fatigue; (2) the use of the stylus may have offered too much freedom of movement, so that the work could be shifted from one set of muscles to another during the trial. In fact the latter objection was at once seen to be valid in preliminary trials with the stylus, for very often the last 300 taps would be more rapidly executed than the first 300, owing to a shift at that point from one set of muscles to another.

The method finally adopted for obtaining a measure of fatiguability was as follows. A telegraph key was attached to the apparatus described under the tapping test, and each subject tapped with the first two fingers of the right hand on this key, resting the elbow, meanwhile, on the table. The electric counter was concealed from the subject by a screen, so that it could not be seen when each hundred taps was completed. No subject knew how many hundred taps would be required at any trial; thus the possible influence of the alleged "end spurt" was avoided. The time for each hundred taps was taken with a stop watch, the observer holding a stop watch in each hand, and starting one as she stopped the other. In computing the records the first 600 taps are used. The percentage of fatigue is deter-

mined by finding the ratio of the last 300 to the first 300 taps, thus:

A sample record as taken with the stop watch runs like this: 11.0, 11.6, 11.6, 12.4, 12.6, 13.6. The sum of the first 300 taps is 34.2 (seconds); that of the last 300 taps is 38.6 (seconds). Thus an absolute fatigue of 4.4 seconds is noted, i. e., the subject took 4.4 seconds longer to complete the last 300 taps than to complete the first 300 taps. Now, dividing 38.6 by 34.2 we get the *index of fatigue,* i. e., $\frac{38.6}{34.2} = 1.128$ (index of fatigue), or 12.8 per cent of fatigue. The purpose of the experiment is to determine whether the index of fatigue is higher, or in any way affected, at critical periods. If the index is found to be consistently higher it follows that fatiguability is greater.

Table IX gives the index of fatigue for each daily trial. Table X shows the average index of fatigue in five-day periods, counting backward and forward from each critical period. It is seen that the average of fatigue for critical periods does not differ consistently from that of other periods. For F3 the index is in all cases high at critical periods, but not higher than that often yielded by this subject at other times, and by the control subjects. F2, on the other hand, shows a low index of fatigue at critical periods, as compared with her index at other times.

When curves are platted from Table IX and Table X, it is suggested that there may be a rhythm which includes longer cadences than the month, and is not concomitant with menstruation, since the curves all tend to follow it, and the critical periods of F3 occur on its high places, while those of F2 occur where it runs low. As remarked, the rhythm is merely suggested, not clearly defined and may well be due entirely to chance. It will be desirable to take records of several more periods, and if possible on several more subjects, before stating any conclusion regarding fatiguability. In the case of F3 the curves may well be interpreted to mean greater fatiguability at critical periods; in the case of F2 the interpretation may well be exactly reversed. No final conclusion will be stated with regard to the matter in this monograph.

A table like Table III under the tapping test was not compiled for fatiguability, because there is no practice here. The standard remains the same throughout the course of the experiment (1.000), and does not vary as in a practice curve.

TABLE IX

INDEX OF MOTOR FATIGUABILITY

Ratio of last 300 taps to first 300 taps (time in seconds), for individuals M1, F2 and F3. Menstrual periods are denoted by stars (*).

DATE		M1	F2	F3	DATE		M1	F2	F3
Sept.	29	1.060	1.135	.950	Nov.	19	1.213	.964	1.140
	30	.954	1.096	1.030		20	.947	1.005	.930
						21	1.033	1.137	1.235*
Oct.	1	1.087	1.037	.890		22	1.190	1.023	.990*
	2	1.020	.980	1.198		23	1.030	1.050	.980*
	3	1.120	1.160	1.070		24	1.295	1.022	1.088*
	4	.966	1.050	.990		25	1.158	1.302	1.012*
	5	1.087	1.116	1.028		26	1.074	1.178	.962
	6	1.113	.982	1.040		27	1.005	1.043	.988
	7	.970	1.210	1.000		28	.860	1.163	1.005
	8	.975	1.078	1.070		29	1.068	1.116	1.023
	9	1.102	.914	1.053		30	.975	1.093	.962
	10	1.058	1.030	.982					
	11	1.133	1.057	1.025	Dec.	1	1.204	1.178	1.054
	12	1.130	1.122	.988		2	1.154	.945	1.083
	13	1.007	.956	.978		3	1.128	.932	.990
	14	.995	1.100*	.956		4	1.079	1.082	.955
	15	1.070	1.190*	.984		5	1.122	1.200	1.050
	16	.976	.960*	1.058		6	.976	1.048*	.992
	17	1.174	.970*	.930		7	1.160	1.040*	.958
	18	1.115	.982*	1.005		8	.970	1.070*	.985
	19	1.007	1.124	1.000		9	1.000	1.074*	1.005
	20	1.110	1.145	.985		10	1.012	1.190*	.930
	21	1.068	1.147	.975		11	1.108	1.000	1.130
	22	1.040	1.134	1.030		12	1.077	1.128	1.053
	23	1.190	1.032	.975		13	1.038	.990	.990
	24	1.095	1.118	1.030*		14	1.080	1.174	.951
	25	.995	1.220	1.066*		15	1.000	1.028	1.005
	26	1.080	.970	.982*		16	1.113	1.200	1.076
	27	1.033	1.010	.972*		17	1.080	1.275	1.070
	28	1.043	1.152	1.070*		18	1.000	1.105	1.022
	29	1.055	1.083	1.130		19	1.135	1.190	1.134
	30	1.028	1.108	1.050		20	1.005	1.173	1.080
	31	1.080	.980	.935		21	1.005	1.122	1.060
						22	.854	1.000	1.211
Nov	1	1.170	1.068	.975		23	.995	1.051	1.082
	2	1.078	1.198	.940		24	1.032	1.080	1.241*
	3	1.255	1.005	.920		25	.983	1.208	1.034*
	4	.960	1.053	1.028		26	1.035	.995	1.110*
	5	1.030	1.097	1.090		27	1.161	1.062	1.003*
	6	1.005	1.073	1.030		28	1.118	1.090	1.073*
	7	1.149	1.092	1.005		29	1.138	1.090	1.064
	8	1.020	.988	.955		30	1.020	1.128*	1.030
	9	1.116	1.013	1.050		31	.947	.917*	1.034
	10	1.075	.900*	1.015					
	11	.995	.910*	.910	Jan.	1	1.046	1.134*	1.086
	12	.943	1.000*	.935		2	1.159	1.031*	1.038
	13	1.030	1.106*	.865		3	1.193	1.000*	1.088
	14	1.131	1.081*	1.140		4	.964	1.048	.843
	15	1.117	.990	.935		5	1.080	.975	.855
	16	1.098	1.106	.990		6	1.050	1.090	1.090
	17	1.147	1.130	.870		7	1.050	.960	1.020
	18	1.308	1.065	1.103					

TABLE X

DAILY RECORDS OF FATIGUE (SEE TABLE IX) CONVERTED INTO AVERAGES, OF 5-DAY PERIODS EACH

Five day periods are determined by counting backward and forward from menstrual periods. Menstrual periods are indicated by stars (*).

1912–1913			1912–1913			1912–1913		
DATE	M1	M.V.	DATE	F2	M.V.	DATE	F3	M.V.
Sept. 29—Oct. 3...	1.048	.050	Sept. 29—Oct. 3...	1.081	.060	Sept. 29—Oct. 3...	1.028	.086
Oct. 4— 8...	1.022	.060	Oct. 4— 8...	1.087	.062	Oct. 4— 8...	1.026	.024
9— 13...	1.086	.040	9— 13...	1.016	.062	9— 13...	1.005	.026
14— 18...	1.065	.066	14— 18...	1.040*	.084	14— 18...	.987	.038
19— 23...	1.083	.052	19— 23...	1.116	.028	19— 23...	.993	.014
24— 28...	1.053	.032	24— 30...	1.094	.064	24— 28...	1.024*	.040
29—Nov. 2...	1.082	.032	31—Nov. 4...	1.061	.058	29—Nov. 2...	1.006	.066
Nov. 3— 7...	1.079	.098	Nov. 5— 9...	1.053	.042	Nov. 3— 7...	1.017	.040
8— 12...	1.029	.054	10— 14...	.999*	.074	8— 12...	.973	.046
13— 17...	1.105	.031	15— 19...	1.051	.062	13— 16...	.982	.083
18— 22...	1.138	.119	20— 24...	1.047	.048	17— 20...	1.011	.111
23— 27...	1.112	.092	25— 29...	1.160	.065	21— 25...	1.059*	.080
28—Dec. 2...	1.052	.108	30—Dec. 5...	1.072	.089	26— 30...	.988	.021
Dec. 3— 7...	1.093	.052	Dec. 6— 10...	1.084*	.041	Dec. 1— 5...	1.026	.046
8— 12...	1.033	.046	11— 15...	1.064	.068	6— 10...	.974	.024
13— 17...	1.062	.036	16— 20...	1.189	.040	11— 14...	1.036	.060
18— 22...	.999	.056	21— 25...	1.092	.056	15— 18...	1.043	.030
23— 27...	1.041	.050	26— 29...	1.059	.032	19— 23...	1.113	.046
28—Jan. 1...	1.059	.059	30—Jan. 3...	1.042*	.071	24— 28...	1.092*	.068
Jan. 2— 7...	1.083	.062	Jan. 4— 7...	1.118	.051	29—Jan. 2...	1.050	.019
						Jan. 3— 7...	.979	.104

VI

MENTAL TESTS
SPEED AND ACCURACY OF PERCEPTION

The Color Naming Test

The color naming test was conducted as follows: The card designed by Woodworth and Wells[1] was placed face downward at each trial, before the subject. At a signal from the operator the subject turned the card over, and began naming the colors as rapidly as possible from left to right. No errors were allowed. If the subject made a mistake the operator, who held an identical card, quickly said "No," and the subject corrected the error before proceeding. Thus mistakes and confusions were accounted for in the time consumed by them. The time of performance was taken by the operator with a stop watch to the fifth of a second. The same order of the colors was used throughout after the first month, in the case of M1, F1 and F2, since it was thought that some orders always yielded poorer records. In the case of all the other subjects the four orders of the colors were used in rotation, from trial to trial, throughout the experiment. The illumination was the same for all trials.

This test has been used by various investigators. Hollingworth[2] found that it was sensitive to so small an influence as 1 to 2 grains of caffein alkaloid. To quote from this author, the test "is designed to measure the speed with which the name or idea can be brought to consciousness upon the sight of the object, which is in this case a color. . . . As the experiment progresses it affords a measure of the individual's ability to improve by practice, his degree of interference as shown by the tendency of a preceding idea to inhibit or interfere with the correct perception and expression of the next stimulus."

Table XI gives the complete daily records of all seven subjects

[1] Woodworth and Wells, Association Tests, *Psych. Mon.*, No. 57.
[2] H. L. Hollingworth, *op. cit.*, p. 16.

and requires no comment. Table XII gives the result of converting these records into averages of five-day periods each, as described for Table II under the tapping test.

In Table XII it is seen that the averages marked (*) form a consistent part of an ordinary practice curve. They show no uniform tendency to rise above records preceding them, and thus to indicate inefficient performance. It will be noted, particularly after the first great drop in practice, that every average does not improve over the average preceding it. This is just as true for control records as for records marked (*), and is a familiar feature of practice curves without regard to sex.[3]

Table XII shows that out of the fifteen critical averages herein noted, nine are slightly better than, four are slightly worse than, and two are the same as the average preceding. This is about what would be found in the case of any twelve averages taken at random in the table.

The mean variability of records made during critical periods is neither uniformly greater nor uniformly less than that of other records. The M. V.'s in the color naming test are greater than in the tapping test, but they are small enough to demonstrate the reliability of the figures.

Table XIII was compiled in the same way as Table III in the tapping test. The purpose of Table XIII was the same as that of Table III, i. e., to compare the average of the critical period with a standard of efficiency (which is the average of the averages of periods immediately before and after it); to examine the average performance of four critical days, excluding the first; and to determine whether the first day shows a remarkable impairment.

F1 is first considered in this table. The critical period is once worse than the standard (33.8*-31.6), and twice slightly better than the standard (36.7*-38.2, and 27.5*-28.1, respectively).

In the case of F2 the critical average is twice slightly worse than the standard of efficiency (41.9*-40.7, and 28.6*-28.1, respectively), the difference being both times within the M. V., and twice slightly better than the standard (44.4*-44.9, and 34.3*-34.7, respectively), this difference also being well within the M. V.

In the case of F3 the critical average is once the same as,

[3] E. L. Thorndike, *op. cit.*, p. 168-169.

once slightly worse than, and once slightly better than the standard of efficiency (40.3*-40.4, 37.1*-36.6, and 33.2*-34.1, respectively), these differences all being within the M. V.

F4 shows both critical averages included in her record slightly worse than the standard, the difference being well within the M. V. (43.7*-43.2, and 40.8*-40.2, respectively); and F6 shows practically no deviation in either direction from the standard of efficiency at critical periods.

It must be concluded that this experiment shows no real influence, either adverse or favorable, on the average of performance for critical periods. An examination of the control records will give the same result that is yielded by the critical records.

Table XIII demonstrates that first days of critical periods bear about the same relation to the averages in which they are included and to the averages preceding as is to be found in the case of the pseudo-first days of the control.

When curves are platted from Tables XI and XII, the menstrual periods do not rise in "blocks" of inefficient performance. In only one case out of twelve is the critical "block" high between the "blocks" preceding and following, i. e., the second period in the case of F1. This one instance is typical of what we should expect to find in all cases, or at least in a great majority of cases, if there were marked impairment during menstrual periods.

On the whole, the performances of F1, F2, F3, F4 and F6 follow the uninterrupted course of the familiar practice curve. They are distinguished from the performances of M1 and M2 by no peculiarities.

It may be objected that this test after scores of repetitions became automatic, and that the processes of perception, inhibition, association, etc., were no longer truly measured; or even, since the same order of the colors was used in some cases, that these subjects must have memorized the colors in order. Therefore five trials were made with each subject after the experiment was entirely finished, as follows. The names of the colors were typewritten on a piece of white paper from left to right, so that *reading* them would involve the same number of eye movements as the naming had previously involved. The subject was then required to *read* the colors in the same way as he or she had

previously named them. This performance, though by no means purely automatic, was undoubtedly much more nearly so than the *naming* of the colors. The time in seconds of each of the six individuals for this test is given below. The records show how far the color naming was from being a memory feat or a purely automatic performance, even after a hundred and twenty-seven trials and more.

READING COLORS

Trial	M1	F1	F2	F3	M2	F4	F6
1.....	24.0 sec.	20.8 sec.	19.0 sec.	29.0 sec.	27.0 sec.	29.0 sec.	25.4 sec.
2.....	24.6 "	20.4 "	20.0 "	27.4 "	26.5 "	26.4 "	26.2 "
3.....	23.0 "	23.2 "	19.0 "	28.2 "	26.8 "	25.4 "	25.4 "
4.....	21.8 "	19.6 "	20.4 "	29.4 "	26.8 "	25.4 "	24.8 "
5.....	21.8 "	20.8 "	19.0 "	28.2 "	26.4 "	25.6 "	24.0 "

TABLE XI

DAILY RECORD OF THE COLOR NAMING TEST

Time required (in seconds) to name 100 colors, by individuals M1, F1, F2, F3, M2, F4 and F6. The menstrual periods are denoted by stars (*).

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913–Feb. 5, 1914
Day	M1	F1	F2	F3	M2	F4	F6
1	40.2	57.8	45.0	47.7	57.3	47.5	72.0
2	45.6	40.8	45.6	48.2	51.9	47.4	75.3
3	39.0	44.8	46.6	47.8	51.0	47.9	64.2
4	37.4	39.8	46.0	47.1	51.6	45.7	60.8
5	39.6	41.0	46.6*	49.4	51.0	46.0	62.3
6	41.0	42.0	47.2*	46.7	51.6	45.9	62.5
7	42.4	42.4	47.6*	49.7	48.5	46.0	55.3
8	43.0	41.6	47.8*	46.6	47.4	48.8	62.4
9	43.2	41.6	46.4*	46.7	51.0	45.3	59.6
10	36.6	38.2	42.2	46.6	52.2	45.6	57.0
11	37.2	39.8	42.6	44.5	50.9	45.8	58.2
12	37.8	41.6*	43.0	45.0	54.0	42.9	Abs.
13	42.0	37.0*	43.0	46.1	49.7	42.8	57.3
14	35.0	36.6*	43.8	47.3	51.7	42.8	56.6*
15	40.6	40.2*	43.4	41.7	49.0	43.5	55.9*
16	37.2	34.6*	42.0	45.7	45.5	41.3	54.4*
17	41.6	39.0	44.0	44.7	46.0	45.5*	57.8*
18	38.8	34.6	44.0	43.7	49.4	42.1*	54.3*
19	40.8	35.0	46.4	44.8	42.7	43.2*	52.1
20	34.2	37.2	43.2	41.7	52.9	44.0*	53.1
21	44.0	38.6	47.2	39.9	45.9	45.4	54.1
22	41.6	37.2	44.6	43.9	48.6	42.9	53.4
23	40.8	42.0	Abs.	42.0	45.1	44.3	54.0
24	34.0	34.2	Abs.	41.0	45.1	42.5	52.8
25	37.6	38.6	44.2	39.4	47.7	41.9	52.0
26	35.2	35.6	42.2	41.3*	47.2	41.9	54.0

TABLE XI—(Continued)

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913–Feb. 5, 1914
Day	M1	F1	F2	F3	M2	F4	F6
27	32.0	34.8	41.2	38.8*	46.6	41.5	56.0
28	36.0	36.6	41.6	43.2*	48.1	44.0	50.6
29	32.2	39.0	41.2	40.0*	47.1	43.5	51.2
30	35.0	39.4	45.4	38.1*	42.4	41.4	55.5
31	34.6	36.8	43.0	39.6	40.9	41.6	54.9
32	35.0	36.0	42.2*	41.0	48.5	41.5	55.4
33	33.6	34.6	40.0*	40.5	42.3	41.5	53.9
34	34.4	36.0	39.4*	39.6	42.3	41.5	56.5
35	35.0	31.8	39.8*	38.0	44.9	39.5	56.5
36	33.0	32.6	43.4*	41.7	43.4	39.6	51.0
37	34.6	31.8	38.8	39.0	44.7	39.7	50.2
38	40.2	37.0	42.2	39.5	40.3	39.2	52.0
39	34.2	31.4	45.4	38.5	44.1	40.8	53.4
40	34.6	29.2*	40.0	39.4	46.9	41.3	52.4
41	34.4	31.8*	40.4	39.3	46.5	41.4	49.7
42	37.6	32.6*	36.4	35.8	45.0	43.8	51.0
43	36.8	34.0*	41.8	36.4	43.1	38.7	52.6
44	34.4	34.0*	38.4	39.1	45.4	40.2*	51.6
45	36.0	35.6	39.0	39.5	43.9	40.2*	53.3
46	33.0	31.4	36.4	38.8	42.3	42.9*	48.8
47	31.6	34.2	41.0	37.9	43.8	40.5*	Abs.
48	36.2	31.0	38.8	40.9	42.8	40.1*	Abs.
49	33.0	32.8	39.0	40.3	41.2	39.4	Abs.
50	32.0	30.4	37.4	36.8	46.6	38.7	Abs.
51	39.0	31.4	37.2	38.3	40.8	39.2	50.3
52	36.4	28.0	34.4	36.5	39.9	36.9	49.3
53	29.0	36.8	33.6	36.5	39.9	41.8	52.6
54	39.2	29.6	39.2	33.9*	39.0	36.1	50.6
55	33.4	31.4	35.2	39.9*	45.8	37.8	49.3
56	32.0	30.4	36.2	37.3*	....	....	53.5
57	38.0	33.4	35.8*	36.1*	....	....	51.1
58	31.6	35.0	35.6*	38.2*	....	....	53.7
59	36.8	34.6	41.0*	36.9	....	....	Abs.
60	32.8	32.8	32.8*	37.0	....	....	52.1*
61	35.2	28.8	31.4*	37.1	....	....	50.3*
62	39.2	34.2	33.0	35.7	....	....	51.7*
63	38.4	28.8	33.4	33.6	....	....	48.7
64	33.6	31.4	34.6	35.3	....	....	51.8
65	31.8	31.4	33.6	38.3	....	....	50.5
66	30.7	30.5	33.2	37.5	....	....	49.8
67	32.7	31.6	32.2	31.7	....	....	49.7
68	34.8	32.2	31.6	33.9	....	....	53.2
69	34.1	31.3	31.9	33.1	....	....	50.6
70	34.4	30.2	31.7	37.1	....	....	48.8
71	37.9	29.7	29.7	39.7	....	....	49.1
72	30.9	28.9	30.8	35.9	....	....	50.0
73	33.1	30.6*	30.3	36.1	....	....	Abs.
74	32.9	27.6*	30.0	37.6	....	....	48.3
75	32.3	38.7*	30.4	34.0	....	....	46.3
76	28.6	27.3*	28.0	35.2	....	....	49.7
77	32.4	27.0*	28.4	33.8	....	....	49.3

TABLE XI—(Continued)

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913–Feb. 5, 1914
Day	M1	F1	F2	F3	M2	F4	F6
78	28.9	27.2	30.5	34.4	....	....	51.0
79	27.0	27.5	28.4	35.2	....	....	46.8
80	27.7	28.2	29.6	36.0	....	....	52.3*
81	30.6	29.2	29.0	34.0	....	....	49.4*
82	29.3	25.7	26.7	32.8	....	....	49.2*
83	27.9	26.5	29.2*	32.2	....	....	47.7*
84	30.8	25.6	28.7*	34.0	....	....	48.3*
85	29.3	27.5	28.8*	39.7	....	....	47.7
86	26.7	27.1	25.6*	35.4	....	....	....
87	29.6	29.7	30.0*	32.1*	....	....	....
88	29.4	28.6	29.8	35.5*	....	....	....
89	29.9	29.5	28.9	31.7*	....	....	....
90	26.7	24.8	29.9	33.4*	....	....	....
91	28.3	26.7	26.9	33.5*	....	....	....
92	23.6	25.6	26.4	31.7	....	....	....
93	....	....	....	35.5	....	....	....
94	....	....	....	33.7	....	....	....
95	....	....	....	32.5	....	....	....
96	....	....	....	33.1	....	....	....
97	....	....	....	34.3	....	....	....
98	....	....	....	30.7	....	....	....
99	....	....	....	33.5	....	....	....
100	....	....	....	33.7	....	....	....
101	....	....	....	36.2	....	....	....

TABLE XII

DAILY RECORDS OF THE COLOR NAMING TEST (SEE TABLE XI) CONVERTED INTO AVERAGES OF 5-DAY PERIODS EACH

Five day periods are determined by counting backward and forward from menstrual periods. Menstrual periods are indicated by stars (*).

COLOR NAMING TEST

1911–1912				1911–1912				1911–1912				1912–1913			
SUBJECT	M1			SUBJECT	F1			SUBJECT	F2			SUBJECT	F3		
Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %
Dec. 21–Dec. 24	40.8	2.6	6.6	Dec. 21–Dec. 24	45.8	6.0	13.2	Dec. 21–Dec. 22	45.3	.3	.7	Sept. 29–Oct. 3	48.0	.6	1.3
Jan. 2–Jan. 6	41.8	1.2	2.9	Jan. 2–Jan. 6	41.7	.4	.9	Dec. 23–Jan. 4	46.7	.6	1.2	Oct. 4– 8	47.3	1.0	2.1
7– 11	37.7	1.7	4.6	7– 11	38.6	1.6	4.3	Jan. 5– 9	44.4*	2.2	4.9	9– 13	44.9	1.5	3.3
12– 16	39.8	1.4	3.6	12– 16	36.7*	2.3	6.4	10– 14	43.2	.6	1.4	14– 18	44.1	1.1	2.5
17– 21	38.9	3.9	9.9	17– 21	37.8	1.9	5.2	15– 19	45.1	1.4	3.1	19– 23	41.2	1.4	3.4
22– 26	34.6	2.0	5.8	22– 26	36.9	1.5	4.1	20– 21	Abs.	Abs.	Abs.	24– 28	40.3*	1.6	4.0
27– 31	34.5	.4	1.2	27– 31	36.6	1.2	3.4	22– 26	42.1	.9	2.2	29–Nov. 2	39.7	.8	2.0
Feb. 1–Feb. 5	35.4	1.9	5.4	Feb. 1–Feb. 4	33.3	1.9	5.6	27– 31	36.6	1.2	3.4	Nov. 3– 7	39.6	.8	2.0
6– 10	35.6	1.2	3.5	5– 8	31.3	1.0	3.2	Feb. 1–Feb. 5	41.9*	2.1	4.9	8– 12	38.0	1.5	4.0
11– 15	34.0	1.7	5.1	9– 13	33.8*	1.0	3.0	6– 10	39.4	1.6	4.1	13– 16	39.5	1.1	3.8
16– 20	33.7	3.2	9.4	14– 18	30.8	1.1	3.6	11– 15	38.8	1.0	2.6	17– 20	37.0	.6	1.6
21– 25	34.8	3.0	8.6	19– 23	31.2	2.4	7.6	16– 20	36.3	1.8	5.1	21– 25	37.1*	1.7	4.6
26–Mar. 1	36.5	2.0	5.4	24– 28	32.9	1.7	5.2	21– 25	36.4	1.1	3.2	26– 30	36.1	1.1	3.0
Mar. 2– 6	32.7	1.2	3.6	29–Mar. 4	31.3	1.3	4.1	26–Mar. 1	34.3*	2.7	7.6	Dec. 1–Dec. 5	35.3	2.0	5.7
7– 11	34.1	1.7	4.9	Mar. 5– 8	31.3	.6	1.8	Mar. 2– 6	33.0	.9	2.8	6– 10	36.4	1.6	4.4
12– 16	31.0	1.8	5.9	9– 12	29.2	1.0	3.3	7– 11	31.3	.8	2.6	11– 14	35.2	1.3	3.7
17– 21	28.5	1.2	4.1	13– 17	27.5*	.4	1.6	12– 16	29.5	1.0	3.4	15– 18	34.9	.7	2.0
22– 26	29.2	.9	3.1	18– 22	27.0	1.1	4.2	17– 22	28.6	.7	2.5	19– 23	34.8	2.2	6.3
27– 30	27.1	2.0	7.4	23– 27	28.5	.9	3.3	23– 27	28.6*	1.2	7.7	24– 28	33.2*	1.1	3.3
				27– 30	25.7	.7	2.6	28– 30	27.7	1.4	5.2	29–Jan. 2	33.3	1.0	3.0
												Jan. 3– 7	33.7	1.3	3.9

TABLE XII—(Continued)

1913				1913				1913–1914			
Subject	M2			Subject	F4			Subject	F6		
Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %
April 19–April 22	55.0	3.3	6.0	April 19–April 22	47.1	.7	1.5	Nov. 13–Nov. 15	70.5	4.2	6.0
23– 26	49.5	1.7	3.4	23– 26	46.4	1.1	2.4	16– 20	60.6	2.2	3.6
27– 30	52.0	1.1	2.1	27– 30	44.9	1.0	2.2	21– 25	58.0	.9	1.5
May 1–May 4	48.9	1.8	3.7	May 1–May 4	42.6	.7	1.6	26– 30	55.8*	1.2	2.1
5– 8	47.7	3.4	7.1	5– 8	43.7*	1.1	2.5	Dec. 1– 5	53.3	.6	1.1
9– 12	46.2	1.2	2.6	9– 12	43.8	1.1	2.5	6– 10	53.1	1.5	2.8
13– 17	47.3	.4	1.0	13– 17	42.6	1.0	2.3	11– 15	54.2	1.3	2.4
18– 22	43.3	2.1	4.9	18– 22	41.5	0.4	.2	16– 20	53.2	2.6	4.8
23– 26	43.3	1.5	3.5	23– 26	39.5	.2	.5	21– 25	51.8	1.2	2.3
27– 31	45.1	1.3	2.9	27– 31	41.2	1.2	2.9	26– 30	51.2	1.6	3.1
June 1–June 5	43.6	.9	2.1	June 1–June 5	40.8*	.9	2.2	31–Jan. 4	50.7	1.2	2.4
6– 10	41.7	2.0	4.8	6– 10	39.2	1.1	2.8	Jan. 5– 7	51.1	1.6	3.1
11– 12	42.4	3.4	8.0	11– 12	37.0	.8	2.2	8– 10	52.4	1.3	2.5
								11– 13	51.4*	.7	1.4
								14– 16	50.3	1.1	2.2
								17– 20	50.8	1.1	2.0
								21– 25	49.1	.5	1.0
								26– 30	48.6	1.7	3.5
								31–Feb. 4	49.4*	1.2	2.4
								Feb. 5.....	47.7	0.0	0.0

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TABLE XIII

Color Naming Test

Shows average performance for the 5 days preceding, the 5 days during, and the 5 days following each menstrual period

Shows also the average performance for 4 days of each menstrual period, excluding the first day which is given separately. Shows also control records. Menstrual periods are indicated by stars (*).

Record of F1

	Subject	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month.	F1	38.6	1.6	4.3	36.7*	2.3	6.4	37.8	2.0	5.2	38.2	35.8*	1.6	4.5	40.2*
	F2 (control)	42.9	.4	.9	43.9	1.0	2.3	45.0	1.5	3.3	43.9	44.1	1.2	2.7	43.4
	M1 (control)	37.7	1.7	4.6	39.8	1.4	3.6	38.9	3.9	9.9	38.4	39.6	1.6	4.0	40.6
2nd month.	F1	32.4	1.9	5.9	33.8*	1.0	3.0	30.8	1.1	3.6	31.6	33.8*	1.2	3.5	34.0*
	F2 (control)	40.9	2.3	5.6	39.3	1.7	4.3	38.3	.8	2.1	39.6	38.7	1.3	3.4	41.8
	M1 (control)	36.2	2.2	6.1	34.4	1.6	4.6	34.5	2.5	7.2	35.4	33.8	1.5	4.4	36.8
3rd month.	F1	29.2	1.0	3.3	27.5*	.4	1.6	27.0	1.1	4.2	28.1	27.3*	.2	.7	28.7*
	F2 (control)	30.5	.6	2.0	29.1	1.0	3.4	28.6	.8	2.8	29.6	28.8	.8	2.8	30.4
	M1 (control)	33.8	1.8	5.3	29.8	2.0	6.7	29.3	1.2	4.0	31.6	29.2	1.6	5.5	32.3

TABLE XIII—(Continued)

RECORD OF F2

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month.	F2	46.7	.6	1.2	44.4*	2.2	4.9	43.2	.6	1.4	44.9	43.6*	1.5	3.4	47.8*
	F1 (control)	42.0	1.3	3.1	40.6	1.2	2.9	37.5	1.7	4.5	39.8	40.3	1.3	3.2	41.6
	M1 (control)	39.6	2.8	7.1	39.3	2.5	6.4	39.9	1.5	3.8	39.8	38.7	2.3	5.9	43.0
2nd month.	F2	42.0	1.8	4.4	41.9*	2.1	5.0	39.4	1.6	4.1	40.7	42.4*	2.0	4.7	39.8*
	F1 (control)	36.6	1.2	3.4	32.9	1.6	4.9	32.7	1.4	4.3	34.7	33.2	1.9	5.7	31.8
	M1 (control)	34.5	.4	1.2	35.4	1.9	5.4	35.6	1.2	3.5	35.1	35.5	2.4	6.7	35.0
3rd month.	F2	36.4	1.1	3.2	34.3*	2.7	7.6	33.0	.9	2.8	34.7	32.7*	.6	1.8	41.0*
	F1 (control)	33.3	2.1	6.3	31.8	2.4	7.5	31.7	.5	1.6	32.5	31.2	2.4	7.7	34.6
	M1 (control)	34.8	3.0	8.6	36.5	2.0	5.4	32.7	1.2	3.6	33.8	36.4	2.4	6.6	36.8
4th month.	F2	28.6	.7	2.5	28.6*	1.2	4.2	27.7	1.4	5.2	28.1	28.6*	1.5	5.2	28.8*
	F1 (control)	27.0	1.1	4.2	28.5	.9	3.3	25.7	.7	2.7	26.4	28.7	.9	3.1	27.5
	M1 (control)	29.3	1.2	4.1	29.0	.9	3.1	26.2	2.6	9.9	27.8	28.9	1.1	3.8	29.3

TABLE XIII—(Continued)

RECORD OF F3

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month.	F3.....	41.2	1.4	3.4	40.3*	1.6	4.0	39.7	.8	2.0	40.4	40.0*	1.6	4.0	41.3*
2nd month.	F3.....	37.0	.6	1.6	37.1*	1.7	4.6	36.1	1.1	3.0	36.6	37.9*	1.2	3.2	33.9*
3rd month.	F3.....	34.8	2.2	6.3	33.2*	1.1	3.3	33.3	1.0	3.0	34.1	33.5*	1.0	3.0	32.1*

RECORD OF F4

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month.	F4.....	42.6	.7	1.6	43.7*	1.1	2.5	43.8	1.1	2.5	43.2	43.1*	.7	1.6	45.5*
	M2 (control)....	48.9	1.8	3.7	47.7	3.4	7.1	46.2	1.2	2.6	47.6	48.3	3.8	7.8	46.0
2nd month.	F4.....	41.2	1.2	2.9	40.8*	.9	2.2	39.2	1.1	2.8	40.2	40.9*	1.0	2.4	40.2*
	M2 (control)....	45.1	1.3	2.9	43.6	.9	2.1	41.7	2.0	4.8	43.4	43.2	.7	1.6	45.4

TABLE XIII—(Continued)

RECORD OF F6

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month .	F6.....	58.0	.9	1.5	55.8*	1.2	2.1	53.3	.6	1.1	55.7	55.6*	1.0	1.8	56.6*
2nd month.	F6.....	52.4	1.3	2.5	51.4*	.7	1.3	50.3	1.1	2.0	51.4	51.0*	.7	1.4	52.1*
3rd month.	F6.....	48.6	1.7	3.5	49.4*	1.2	2.4	Not Completed	.....	.....	.....	48.7*	.7	1.5	52.3*

VII

CONTROLLED ASSOCIATION

The Opposites Test

A clear discussion of this test and a list of the investigations carried on by means of it will be found in Whipple's "Manual of Mental and Physical Tests." For the present purpose a list of fifty words was used, as follows:

attractive	loud	dangerous	drunk	aristocratic
helpless	idle	rash	sacred	broad
prompt	savage	graceful	coarse	noisy
foreign	defective	vague	ancient	innocent
cowardly	public	masculine	hostile	gentle
peculiar	wise	ripe	fickle	gay
harmonious	shallow	slovenly	timid	soothing
beautiful	cloudy	talkative	sickly	stormy
fertile	tragic	doubtful	lazy	sharp
brief	expensive	stale	victorious	past

These words were typewritten on a card in two vertical columns. This card was laid face downward before the subject at each trial, and at a given signal from the operator the subject turned it over and went through the list as rapidly as possible, naming the opposite to each word in order. The *opposites only* were uttered, the words on the card not being pronounced. The time was taken by the operator with a stop watch to the fifth of a second. As in the color naming test, no errors were allowed. The words were arranged in 20 chance orders, and thus the order was never the same for successive trials. F2 was already well down on her practice curve at the beginning of this test, having previously gone over this list of opposites a great many times as operator.

This is a test of controlled association processes. Hollingworth[1] says of it, "The opposites test is a much used one in experimental and educational psychology, and has been found

[1] H. L. Hollingworth, *op. cit.*, p. 18.

to correlate to a fairly high degree with other tests designed to measure mental ability. . . . This test indicates the ability of the individual to select the appropriate response from the host of ideas which follow in the wake of a stimulus word. It is an index of speed, accuracy, linguistic feeling, and of ability to repress useless or irrelevant ideas. . . . It is a test of association processes, but of association processes of a considerably more complex kind than those involved in the color naming test."

Woodworth and Wells[2] take the association test to be "A measure of mental alertness," and "of efficient mental control." It may also be added here that these investigators found the opposites test to be the best representative of controlled association tests.

Stern[3] also gives figures to show the high degree of correlation between the opposites test and other tests for efficiency. Since it correlates closely with other mental tests, the inference is fair that it should yield a representative measure of general mental efficiency at a given period.

The complete daily records of the seven subjects are given in Table XIV. The records converted into averages as under the tapping test (Table II) are given in Table XV.

Examining the contents of Table XV, we find that the records marked (*) form a consistent part of an ordinary practice curve. They show no uniform tendency to rise above the records preceding, and thus to indicate characteristic lapses from efficiency. It is to be noted, particularly after the first great drop in practice, that here, as in the other tests, every average does not improve over the average preceding it. This is just as true for control records as for records marked (*), and is indeed a well recognized feature of practice curves[4] without regard to sex.

To summarize the results of Table XV briefly and specifically, out of the fifteen critical averages herein recorded, eight are slightly better than, four are slightly worse than, and three are the same as the record preceding. This is about what would

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[2] Woodworth and Wells, *op. cit.*, p. 5, 59.
[3] Stern, Die Differentielle Psychologie, 1911, p. 488.
[4] E. L. Thorndike, *op. cit.*, pp. 168-169.

be found in the case of any twelve averages taken at random from the table.

The mean variability of records made during critical periods reveals no uniform tendency. The M. V.'s for the opposites test are greater than those for the tapping test; yet they are low enough to demonstrate that the figures are quite reliable.

Table XVI was compiled in the same way as Table III, described under the tapping test. The purpose of Table XVI, as of Table III in the tapping test, is to compare the average performance of the critical period with a standard of efficiency (which is the average of the averages of periods immediately before and after); to examine into the average performance of four critical days, excluding the first; and to determine whether the first day shows a remarkable degree of impairment.

F1 is first considered in this table. On the first month, while the records were more variable than later, owing to the great amount of practice, the record of F1 for the critical period is 38.9* as compared with 37.0, the standard of efficiency for that particular period. The difference is, however, within the M. V. On the remaining two months the records of the critical periods equal the standards (30.1*-29.8, and 27.2*-27.0, respectively).

In the case of F2 the first two periods do not measure up to their standards (31.2*-29.8, and 27.7*-26.3, respectively). The difference between the first of these, however, is within the M. V. On the remaining two months the records of the critical periods equal the standards (24.5*-24.3, and 23.9*-23.7, respectively).

In the case of F3 the critical period is twice the same as the standard (32.7*-32.8, and 29.8*-29.8, respectively), and once slightly worse than the standard (39.9*-39.3), the difference being within the M. V.

The record of F4 shows the critical period to be twice slightly worse than the standard (33.7*-32.9, and 25.2*-24.5, respectively), the difference being both times within the M. V.

The record of F6 shows the critical period to be slightly better than the standard in one of the two cases where the record for the whole month was completed (54.8*-56.0), and in the other instance to be slightly worse than the standard (39.5*-38.6), these differences being well within the M. V.

It must be concluded that this experiment discovers no real influence, either adverse or favorable, on the average of performance for critical periods. An examination of the control records will show the same result that the critical records yield.

Turning now to the first days, it is seen in the case of F1 that all records for first days are very slightly worse than the averages in which they are included, as well as slightly worse than the averages that precede them. The first two months for F2 show first days considerably worse than the averages in which they are included, and worse than the averages preceding them. On the last two critical periods for F2 the first days equal the averages in which they are included. The record of F3 shows one first day worse than the record in which it is included, one the same as the record in which it is included, and one slightly better than the record in which it is included. F4 shows one first day worse and one first day better than the average in which it is included. F6 shows one first day better and two first days worse than the averages in which they are respectively included.

This general result would seem to indicate a degree of impairment on first days in the opposites test, nine first days out of the fifteen herein recorded being worse than the averages in which they are respectively included, as well as worse than the average which precedes. But a scrutiny of control records shows the same "worseness" on pseudo-first days, as witness for example the record of M1 (control for F2) on the fourth month, or the record of F2 (control for F1) on the first month. This fact, combined with the smallness of the differences, renders the conclusion very doubtful that there is genuine impairment on first days. The only degree of "worseness" which is noticeable is in the case of the first two first days for F2, and it must be remembered that on these days F2 suffered pain for a short time. It seems not at all improbable that the opposites test was adversely affected by this suffering, especially since F2 shows no impairment whatever on the two remaining first days, when no pain was experienced.

When curves are platted from Tables XIV and XV, the menstrual periods are not characterized by inefficiency. The curves follow the downward direction of the ordinary practice curve, as they did in the case of the color naming. No period

of maximum efficiency recurring regularly in each month and no "cycle" are revealed, even after the curves have attained a fair practice level. On the whole, the performances of F1, F2, F3, F4 and F6 follow the same course as those of M1 and M2, and are distinguished from the latter by no peculiarities.

As in the case of the color naming, it may be objected that this test, after many repetitions, became automatic, and that the processes of association, inhibition, etc., were no longer truly measured, although the varying order of the words did preclude the possibility of pure memory work. Therefore five trials were made with each subject when the experiment was entirely finished, as follows. The opposites to the words on the card were typewritten in exactly the same way as the words themselves, in two vertical columns. The subject then *read the opposites,* turning the card over, and performing exactly as he or she had done previously. The records for these trials are given below. They show how far the process was from being automatic, even after more than a hundred and twenty-five trials. The subjects could articulate the opposites when placed before them, about twice as rapidly as they could call them up by association and articulate them.

READING OPPOSITES

TRIAL	M1	F1	F2	F3	M2	F4	F6
1	13.8	13.8	15.6	16.0	13.8	14.4	15.2
2	13.2	13.8	14.8	17.0	14.2	13.0	14.6
3	14.0	13.8	14.0	16.8	13.0	12.4	14.0
4	13.2	13.2	15.0	16.0	12.8	13.0	13.6
5	14.0	13.6	12.4	16.8	13.8	12.8	14.2

TABLE XIV

DAILY RECORD OF THE OPPOSITES TEST

Time required (in seconds) to give 50 opposites, by individuals M1, F1, F2, F3, M2, F4 and F6. The menstrual periods are denoted by stars (*).

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913–Feb. 5, 1914
Day	M1	F1	F2	F3	M2	F4	F6
1	48.4	73.8	35.4	60.6	92.0	81.7	131.6
2	42.2	62.8	33.0	53.5	64.0	64.7	78.7
3	45.0	67.0	32.2	54.1	63.4	55.3	83.2
4	51.4	63.2	30.6	65.6	64.0	53.3	73.6
5	45.6	52.0	33.8*	51.1	55.9	50.0	62.4
6	43.2	51.6	32.0*	60.2	62.1	46.0	80.1
7	39.0	47.2	31.4*	54.6	57.7	42.9	62.8
8	42.2	40.0	36.2*	62.4	62.0	40.0	63.6
9	46.0	38.0	33.0*	48.8	53.2	41.7	63.0
10	39.0	41.0	30.6	50.3	59.0	38.1	59.6
11	39.4	39.4	28.8	49.8	51.3	41.6	60.4
12	39.6	37.8*	27.2	51.4	56.6	37.6	Abs.
13	41.8	39.2*	28.6	50.9	49.7	37.8	56.6
14	42.0	39.6*	29.4	48.4	53.4	33.2	57.8*
15	33.4	40.0*	29.6	46.0	48.5	31.5	53.2*
16	39.6	41.8*	25.6	44.6	48.2	35.4	57.5*
17	39.0	35.4	26.6	46.6	50.0	35.0*	52.1*
18	32.4	39.0	31.8	48.2	50.5	32.7*	53.4*
19	35.6	38.6	24.0	42.1	44.1	33.4*	57.5
20	36.0	33.0	29.6	42.4	50.1	33.5*	57.2
21	35.0	39.0	31.0	43.6	53.8	33.7	48.5
22	39.0	32.2	26.6	38.1	45.6	31.7	47.7
23	34.0	37.0	Abs.	43.4	41.0	30.4	49.5
24	31.8	32.0	Abs.	44.7	44.0	29.5	49.1
25	34.0	40.0	26.2	38.9	43.5	27.7	47.9
26	38.0	32.0	28.0	43.4*	42.0	29.3	46.1
27	30.2	32.8	28.0	38.9*	39.3	27.1	50.0
28	37.0	37.4	30.4	39.0*	45.2	28.4	47.4
29	30.8	33.6	29.4	40.0*	45.8	26.0	48.1
30	37.0	31.6	27.4	38.1*	36.0	27.2	46.8
31	30.8	36.0	26.4	37.4	39.3	26.0	49.2
32	26.6	31.0	26.6*	34.7	39.2	28.0	48.0
33	35.0	34.2	27.0*	38.6	38.0	27.2	47.0
34	41.4	34.4	27.4*	37.9	39.3	27.2	48.1
35	37.6	31.0	30.4*	36.0	37.5	26.9	45.9
36	35.2	32.0	27.4*	34.6	45.7	26.0	45.8
37	33.8	30.2	27.0	34.7	45.7	25.9	44.5
38	32.8	32.4	26.4	32.1	36.0	27.2	45.6
39	33.2	31.0	27.2	37.5	42.0	26.0	44.8
40	32.4	31.8*	25.8	33.4	45.2	25.5	44.7
41	30.6	29.0*	27.0	31.8	42.7	25.4	40.6
42	29.0	28.4*	24.4	36.0	41.2	23.6	42.9
43	30.8	32.0*	26.0	31.6	38.9	26.2	38.5
44	30.0	30.4*	24.6	34.6	35.3	24.5*	40.2
45	33.4	30.2	28.4	33.2	36.7	25.6*	42.8
46	34.2	31.4	26.4	32.2	33.0	23.8*	40.4
47	32.4	26.4	27.4	30.1	39.7	27.2*	Abs.
48	31.2	29.4	27.6	30.3	38.6	24.7*	Abs.
49	28.0	30.2	23.8	33.3	29.7	23.8	Abs.
50	31.4	30.2	27.0	34.8	35.2	24.8	Abs.

TABLE XIV—(Continued)

Date	Dec. 21, 1911–March 30, 1912			Sept. 29, 1912–Jan. 7, 1913	April 19–June 12, 1913		Nov. 13, 1913 Feb. 5, 1914
Day	M1	F1	F2	F3	M2	F4	F6
51	35.4	31.6	23.4	33.8	33.3	22.4	43.3
52	37.6	29.2	27.0	29.4	36.1	23.2	40.4
53	35.4	30.8	25.2	30.9	31.7	24.0	43.1
54	31.6	30.8	24.4	32.6*	32.9	20.3	39.4
55	31.6	30.0	24.6	31.4*	36.2	21.5	44.6
56	31.0	25.2	22.4	36.7*	....	....	41.5
57	30.2	30.0	27.6*	31.2*	....	....	41.0
58	29.8	28.2	22.0*	31.6*	....	....	41.0
59	37.8	30.8	22.8*	33.4	....	....	Abs.
60	28.6	27.8	24.0*	32.8	....	....	39.0*
61	26.6	27.8	24.2*	34.4	....	....	39.1*
62	29.8	32.8	19.6	33.6	....	....	40.6*
63	27.4	29.6	27.0	32.2	....	....	36.0
64	29.2	31.8	28.0	32.6	....	....	36.9
65	28.8	29.0	23.0	31.1	....	....	36.1
66	30.6	26.8	24.0	31.8	....	....	39.4
67	30.2	29.7	25.3	34.4	....	....	36.2
68	31.2	26.1	22.4	29.5	....	....	37.9
69	28.9	29.0	28.5	31.9	....	....	34.3
70	31.8	29.6	24.4	30.7	....	....	34.4
71	32.3	27.4	23.4	29.9	....	....	36.8
72	30.8	27.5	24.0	29.6	....	....	36.8
73	34.0	30.6*	27.0	34.7	....	....	Abs.
74	31.9	27.9*	23.5	33.3	....	....	34.4
75	28.2	24.0*	21.4	30.9	....	....	32.9
76	28.3	27.8*	23.0	33.6	....	....	36.6
77	29.7	26.1*	23.7	31.6	....	....	37.5
78	32.7	25.5	22.6	29.5	....	....	31.9
79	28.3	30.1	26.3	28.0	....	....	33.8
80	28.3	26.6	24.7	30.2	....	....	35.4*
81	29.3	25.2	22.5	32.3	....	....	33.3*
82	29.9	26.6	24.0	31.0	....	....	33.8*
83	32.5	29.0	26.2*	26.9	....	....	34.7*
84	29.0	25.3	23.0*	27.2	....	....	35.0*
85	33.5	26.5	23.7*	30.7	....	....	34.3
86	32.4	26.9	23.6*	30.4	....	....	....
87	35.7	26.7	24.3*	29.5*	....	....	....
88	29.7	25.9	25.0	31.4*	....	....	....
89	31.8	25.3	22.8	30.1*	....	....	....
90	29.4	24.0	24.1	29.7*	....	....	....
91	29.3	23.4	23.1	28.1*	....	....	....
92	30.4	24.9	23.1	26.5	....	....	....
93	29.2	25.8	24.0	32.3	....	....	....
94	....	....	....	32.9	....	....	....
95	....	....	....	29.0	....	....	....
96	....	....	....	32.0	....	....	....
97	....	....	....	31.1	....	....	....
98	....	....	....	31.1	....	....	....
99	....	....	....	26.3	....	....	....
100	....	....	....	29.4	....	....	....
101	....	....	....	28.6	....	....	....

TABLE XV

Opposites Test

Daily records of the Opposites Test (see Table XIV) converted into averages of 5-day periods each

Five-day periods are determined by counting backward and forward from menstrual periods. Menstrual periods are indicated by stars (*).

1911–1912				1911–1912				1911–1912				1912–1913			
Subject	M1			Subject	F1			Subject	F2			Subject	F3		
Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %
Dec. 21–Dec. 24	47.3	2.7	5.6	Dec. 21–Dec. 24	66.7	3.7	5.5	Dec. 21–Dec. 22	34.2	1.2	3.5	Sept. 29–Oct. 3	57.0	4.9	8.5
Jan. 2–Jan. 6	43.2	2.1	4.9	Jan. 2–Jan. 6	45.8	5.4	11.8	23–Jan. 4	32.0	.8	2.5	Oct. 4– 8	55.3	4.8	8.7
7– 11	40.4	1.2	3.1	7– 11	39.4	.7	1.8	Jan. 5– 9	31.2*	2.8	8.8	9– 13	49.3	1.7	3.4
12– 16	36.0	2.6	7.3	12– 16	38.9*	1.6	4.1	10– 14	27.5	1.6	5.8	14– 18	44.8	2.1	4.9
17– 21	35.2	1.9	5.3	17– 21	34.6	2.7	7.8	15– 19	28.6	2.6	9.2	19– 23	41.7	2.6	6.2
22– 26	34.0	2.8	8.2	22– 26	35.2	2.8	8.0	20– 21	Abs.	Abs.	Abs.	24– 28	39.9*	1.5	3.8
27– 31	34.2	4.4	12.7	27– 31	33.4	1.7	5.1	22– 26	28.4	1.2	4.2	29–Nov. 2	36.9	1.5	4.1
Feb. 1–Feb. 5	34.5	1.5	4.3	Feb. 1–Feb. 4	31.4	.7	2.1	27– 31	26.9	.4	1.4	Nov. 3– 7	34.5	1.4	4.1
6– 10	30.6	1.0	3.1	5– 8	30.1	1.4	4.7	Feb. 1–Feb. 5	27.7*	1.1	3.9	8– 12	33.4	1.5	4.5
11– 15	31.8	1.8	5.7	9– 13	30.1*	1.4	4.7	6– 10	25.6	.8	3.3	13– 16	31.5	1.3	4.1
16– 20	34.3	2.2	6.5	14– 18	30.1	.6	2.0	11– 15	26.7	1.3	4.9	17– 20	32.2	2.1	6.5
21– 25	32.1	2.3	7.2	19– 23	29.4	1.6	5.6	16– 20	25.4	1.4	5.5	21– 25	32.7*	1.6	4.9
26–Mar. 1	28.3	1.1	3.7	24– 28	29.5	1.9	6.4	21– 25	23.9	2.0	8.4	26– 30	33.3	.6	1.8
Mar. 2 6	29.9	.9	2.9	29–Mar. 4	29.4	1.2	4.0	26–Mar. 1	24.5*	2,4	9.8	Dec. 1–Dec. 5	31.9	1.3	4.1
7– 11	32.2	.8	2.5	Mar. 5– 8	27.9	1.1	3.9	Mar. 2– 6	24.6	2.0	8.1	6– 10	31.4	1.6	5.1
12– 16	29.4	1.4	4.8	9– 12	27.5	1.4	5.2	7– 11	24.5	1.4	5.7	11– 14	32.4	1.1	3.4
17– 21	29.8	1.1	3.8	13– 17	27.2*	1.4	5.7	12– 16	23.4	1.2	5.1	15– 18	30.0	1.3	4.3
22– 26	32.6	1.6	4.8	18– 22	26.5	1.0	3.8	17– 22	24.0	1.0	4.2	19– 23	29.2	1.8	6.2
27– 30	29.6	.3	1.5	23– 27	25.8	.9	3.5	23– 27	23.9*	1.0	4.2	24– 28	29.8*	.8	2.7
				28– 30	24.7	.8	3.2	28– 30	23.4	.4	1.7	29–Jan. 2	30.5	2.2	7.2
												Jan. 3– 7	29.3	1.4	4.8

TABLE XV—(Continued)

1913				1913–1914				1913–1914			
Subject	M2			Subject	F4			Subject	F6		
Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %	Date	Av. of 5 days	M. V. Sec.	M. V. %
April 19–April 22	70.9	10.6	14.9	April 19–April 22	63.8	6.9	10.8	Nov. 13–Nov. 15	97.8	22.5	23.0
23– 26	59.4	2.6	4.4	23– 26	44.7	3.3	7.4	16– 20	68.5	6.7	9.8
27– 30	55.0	2.8	5.1	27– 30	39.8	1.9	4.7	21– 25	59.9	1.8	3.0
May 1–May 4	50.0	1.8	3.6	May 1–May 4	34.5	2.1	6.1	26– 30	54.8*	2.3	4.2
5– 8	48.7	2.3	4.7	5– 8	33.7*	.7	2.1	Dec. 1–Dec. 5	52.1	4.2	8.1
9– 12	46.1	3.9	8.5	9– 12	31.3	1.4	4.5	6– 10	48.1	1.2	2.5
13– 17	43.2	2.0	4.6	13– 17	27.7	.9	3.2	11– 15	47.8	.7	1.5
18– 22	38.4	1.1	2.9	18– 22	27.1	.5	1.9	16– 20	46.0	.9	1.9
23– 26	41.2	4.5	10.9	23– 26	26.5	.6	2.3	21– 25	42.3	2.2	5.2
27– 31	42.0	1.6	3.8	27– 31	25.3	.7	2.8	26– 30	41.1	1.1	2.7
June 1–June 5	36.7	2.0	5.5	June 1–June 5	25.2*	1.0	4.0	31–Jan. 4	42.3	1.2	2.8
6– 10	33.2	2.0	6.0	6– 10	23.6	.7	3.0	Jan. 5– 7	41.8	1.8	4.3
11– 12	34.6	1.7	4.9	11– 12	20.9	.6	2.9	8– 10	41.0	0.0	0.0
								11– 13	39.5*	.7	1.8
								14– 16	36.3	.4	1.1
								17– 20	36.9	1.7	4.6
								21– 25	35.6	1.2	3.4
								26– 30	34.1	1.9	5.6
								31–Feb. 4	34.4*	.7	2.0
								Feb. 5.....	34.3	0.0	0.0

TABLE XVI

Opposites Test

SHOWS AVERAGE PERFORMANCE FOR THE 5 DAYS PRECEDING, THE 5 DAYS DURING, AND THE 5 DAYS FOLLOWING EACH MENSTRUAL PERIOD

Shows also the average performance for 4 days of each menstrual period, excluding the first day, which is given separately. Shows also control records. Menstrual periods are indicated by stars (*).

RECORD OF F1

	Subject	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month..	F1.....	39.4	.7	1.8	38.9*	1.6	4.1	34.6	2.7	7.8	37.0	38.7*	1.7	4.4	40.0*
	F2 (control).....	28.9	.9	2.9	27.5	2.5	9.2	29.1	1.6	5.6	29.0	27.0	2.4	8.9	29.6
	M1 (control)....	40.4	1.2	3.1	36.0	2.6	7.3	35.2	1.9	5.3	37.8	36.7	2.7	7.2	33.4
2nd month.	F1.....	30.1	1.4	4.5	30.1*	1.4	4.5	30.1	.6	1.2	30.1	29.6*	1.6	5.4	32.0*
	F2 (control).....	26.1	1.0	3.8	26.6	1.1	4.1	25.8	1.7	6.7	26.0	26.7	1.2	4.5	26.0
	M1 (control)....	31.3	1.5	4.8	32.2	1.4	4.3	32.7	3.0	9.2	32.0	32.5	1.3	4.0	30.8
3rd month.	F1.....	27.5	1.4	5.2	27.2*	1.4	5.7	26.5	1.0	3.8	27.0	27.1*	1.5	5.5	27.8*
	F2 (control).....	24.0	1.5	6.2	24.1	1.2	5.0	23.9	1.0	4.2	24.0	24.3	1.2	4.9	23.0
	M1 (control)....	31.2	1.7	5.4	29.5	1.4	4.7	30.8	1.7	5.5	31.0	29.8	1.5	5.0	28.3

TABLE XVI (Continued)

RECORD OF F2

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month	F2	32.0	.8	2.5	31.2*	2.8	8.8	27.5	1.6	5.8	29.8	29.9*	1.9	6.4	36.2*
	F1 (control)	56.2	7.1	12.6	39.2	1.1	2.6	39.2	1.5	2.7	47.7	39.1	1.2	3.1	40.0
	M1 (control)	44.8	3.0	6.7	41.2	2.3	4.9	39.2	2.4	5.3	42.0	41.0	2.0	4.9	42.2
2nd month	F2	26.9	.4	1.4	27.7*	1.1	3.9	25.6	.8	3.3	26.3	27.0*	.3	1.1	30.4*
	F1 (control)	33.4	1.7	5.1	31.3	.7	2.2	30.3	1.3	4.3	31.9	31.4	.8	2.6	31.0
	M1 (control)	34.2	4.4	12.7	34.5	1.5	4.3	30.6	1.0	3.1	32.4	33.8	.8	2.4	37.6
3rd month	F2	23.9	2.0	8.4	24.5*	2.4	9.8	24.6	2.0	8.1	24.3	24.7*	2.8	11.3	24.0*
	F1 (control)	28.8	1.7	5.9	30.0	1.9	6.3	28.1	1.3	4.6	28.5	30.3	1.8	5.9	27.8
	M1 (control)	32.1	2.3	7.2	28.3	1.1	3.7	29.9	.9	2.9	31.0	28.3	1.3	4.6	28.6
4th month	F2	24.0	1.0	4.2	23.9*	1.0	4.2	23.4	.4	1.7	23.7	24.1*	.6	2.5	23.6*
	F1 (control)	26.5	1.0	3.8	25.8	.9	3.5	24.7	.8	3.2	25.6	25.5	.8	3.1	26.9
	M1 (control)	30.8	1.7	5.6	31.8	1.8	5.7	29.6	.5	1.7	30.2	31.7	2.1	6.6	32.4

RECORD OF F3

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days excluding 1st	M. V. Sec.	M. V. %	1st day
1st month	F3	41.7	2.6	6.2	39.9*	1.5	3.8	36.9	1.5	4.1	39.3	39.0*	.5	1.3	43.4*
2nd month	F3	32.2	2.1	6.5	32.7*	1.6	4.9	33.3	.6	1.8	32.8	32.7*	2.0	6.1	32.6*
3rd month	F3	29.2	1.8	6.2	29.8*	.8	2.6	30.5	2.2	7.2	29.8	29.8*	.9	3.0	29.5*

TABLE XVI—(Continued)

RECORD OF F4

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 da after	ysM. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month .	F4.....	34.5	2.1	6.1	33.7*	.7	2.1	31.3	1.4	4.5	32.9	33.2*	.3	.9	35.0*
	M2 (control)....	50.0	1.8	3.6	48.7	2.3	4.7	46.1	3.9	8.5	48.1	48.2	2.8	5.8	50.0
2nd month.	F4.....	25.3	.7	2.8	25.2*	1.0	4.0	23.6	.7	3.0	24.5	25.3*	1.1	3.1	24.5*
	M2 (control)....	42.0	1.6	3.8	36.7	2.0	5.5	33.2	2.0	6.0	37.6	36.8	2.5	6.8	34.6

RECORD OF F6

	SUBJECT	Av. 5 days before	M. V. Sec.	M. V. %	Av. 5 days during	M. V. Sec.	M. V. %	Av. 5 days after	M. V. Sec.	M. V. %	Standard of Efficiency: Av. 5 days before and after	Av. 4 days, excluding 1st	M. V. Sec.	M. V. %	1st day
1st month .	F6.....	59.9	1.8	3.0	54.8*	2.3	4.2	52.1	4.2	8.0	56.0	54.1*	1.8	3.3	57.8*
2nd month.	F6.....	41.0	0.0	0.0	39.5*	.7	1.7	36.3	.4	1.1	38.6	39.9*	.8	2.0	39.0*
3rd month.	F6.....	34.1	1.9	5.5	34.4*	.7	2.0	Not Completed	.....	.....	.....	34.2*	.7	2.0	35.4*

VIII

LEARNING

Typewriting

As a test of ability to *learn* during physiological periods typewriting was chosen, for three reasons: it combines all of the simple processes already tested here; it affords a task easy to standardize; subjects will consent to spend time and effort on it, because they are learning something of benefit to themselves, whereas they excuse themselves from learning nonsense syllables, multiplying, etc. Three subjects took part in the typewriting experiment,—F2, F3 and F5. F2 was already somewhat proficient; F3 was familiar with the mechanism of the typewriter, but had used it only a few times previous to the beginning of this experiment; F5 was also familiar with the mechanism, but had just begun to operate the machine. F5 learned by the *touch* method. F2 and F3 learned by the *sight* method.

The task was to write each day at approximately the same hour, for 28 days, a page from Oscar Wilde's "De Profundis." This book was chosen for the purely incidental reason that it happened to be at hand in a cheap edition which could easily be torn apart. About the same number of words was printed on each page. The subject recorded the time of each performance to the half minute. The number of corrected and of uncorrected errors was counted afterwards.

Table XVII gives the record of each subject in full. Figures 1, 2 and 3 show these records graphically. No rise in the time required is noted at menstrual periods. The process of learning goes forward unarrested in so far as these records indicate.

TABLE XVII

LEARNING: TYPEWRITING

Time required (in minutes) to write one page of "De Profundis," together with corrected and uncorrected errors, for individuals F2, F3 and F5. The menstrual periods are denoted by stars (*).

	F2			F3			F5		
Trial	Time	C. Errors	Uc. Errors	Time	C. Errors	Uc. Errorc	Time	C. Errors	Uc. Errors
1	6.0	4	1	15.5	3	3	13.0	4	1
2	6.5	6	1	14.0	4	6	11.0	2	1
3	6.0	9	2	13.0	2	3	10.5	7	0
4	5.5	6	2	11.0	2	4	12.0	8	2
4	5.5	9		10.0	5	3	11.0	8	0
6	5.5	5	0	13.0	6	1	10.0	5	1
7	5.0	3	2	10.0	3	5	10.5	7	1
8	5.0	5	1	10.0	2	4	10.5	6	1
9	5.5	8	0	10.0	4	6	9.0	3	0
10	5.5*	6*	0*	12.0	2	5	11.0	10	1
11	5.0*	3*	0*	9.5	3	3	9.0*	4*	1*
12	5.0*	5*	1*	9.0*	2*	3*	9.0*	1*	2*
13	5.0*	4*	1*	9.0*	2*	3*	8.5*	6*	1*
14	5.0*	5*	2*	9.0*	3*	4*	8.0*	1*	0*
15	5.0	5	0	9.0*	1*	6*	8.0*	6*	0*
16	4.5	4	2	8.5*	3*	6*	9.0*	6*	1*
17	4.5	5	0	9.0	2	5	8.0	6	1
18	5.0	3	1	10.5	5	6	7.5	3	0
19	5.0	3	0	8.0	1	7	7.0	4	0
20	4.5	4	0	10.0	4	3	7.0	6	1
21	6.0	4		9.0	3	6	7.5	7	3
22	5.0	4	2	8.0	4	6	7.0	2	2
23	5.0	3	0	8.0	0	3	7.0	4	0
24	5.0	3	1	8.0	1	7	7.0	9	0
25	5.0	4	1	7.0	2	6	8.0	8	1
26	6.0	5	1	8.0	4	6	7.5	10	0
27	5.0	3	2	6.0	1	7	7.0	5	2
28	4.5	5	1	6.0	1	5	7.0	1	1

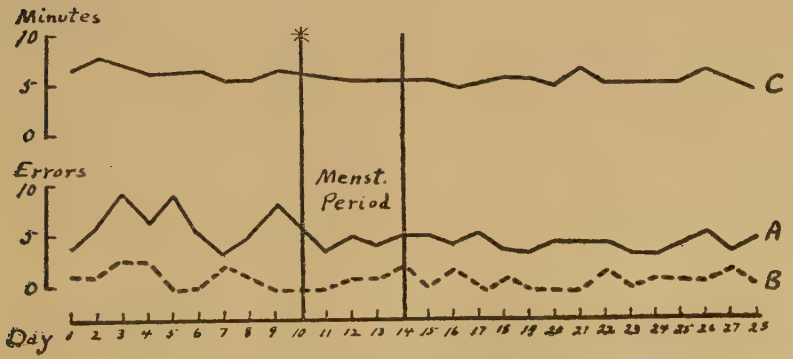

FIGURE 1.—Subject F2. Typewriting.

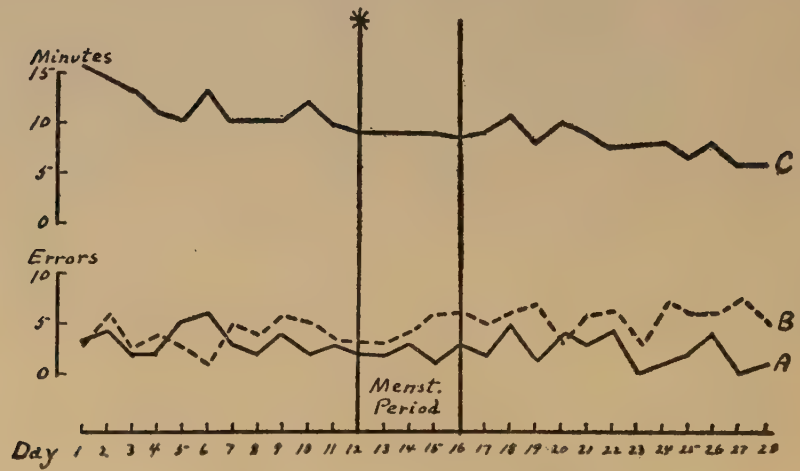

FIGURE 2.—Subject F3. Typewriting.

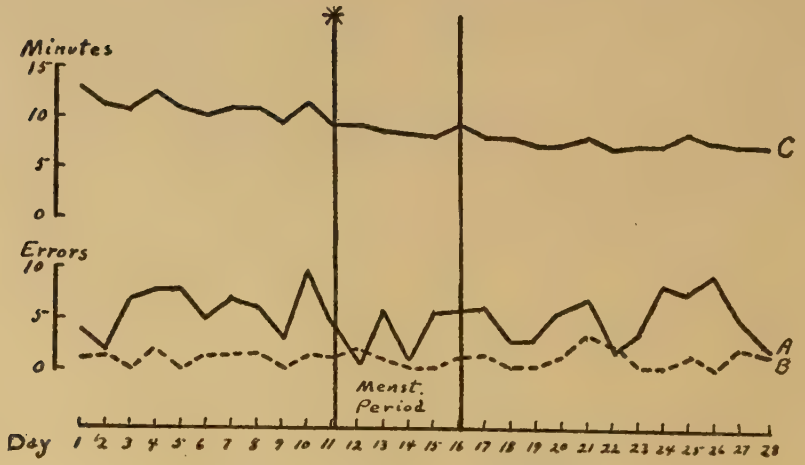

FIGURE 3.—Subject F5. Typewriting.

Figures 1, 2 and 3. Explanatory notes.
Curves A = corrected errors.
Curves B = uncorrected errors.
Curves C = time of performance (in minutes).

IX

CURVES OF PHYSIOLOGICAL PROCESSES COMPARED WITH CURVES OF MENTAL AND MOTOR PERFORMANCE

In 1882 Stephenson[1] published a number of curves platted from Jacobi's figures, which he analyzed according to a method fully set forth in his article on the subject. Jacobi's records comprised observations on temperature, pulse and the excretion of urea. These curves are reproduced in Figure 4, page 78.

The line O represents the course which would have been followed by the functions measured if they had not fluctuated, but had maintained the average straight across the month. When the curve dips below the line O, the function measured falls lower than the average; when the curve rises above, the function is above the average. The curves begin on the first day of the menstrual period. Of the two curves platted along the same average the solid line represents temperature and the broken line pulse.

The curves indicate in a fairly uniform way a fluctuation within each month, and both Jacobi and Stephenson connect this fluctuation with menstruation as a cause, or at least as a closely related and coincident phenomenon. The chief criticism on these data is that no control records were taken on men of the same age and same general condition in life, to determine whether this fluctuation in vital functioning is peculiar to women.

In a general way these curves by Stephenson agree with Van Ott's curve, Figure 12. Van Ott[2] also found that the highest

[1] Stephenson, On the Menstrual Wave, *Am. Jour. Obstet.*, 1882, vol. 15.

[2] Van Ott, Des Lois de la Périodicite da la Fonction Physiologique dans l'Organisme Féminin, *Nouv. Arch. Obstet.*, 1890.

"Outre recherches sur la température, le pouls, la pression sanguine (spygmanomètre de Basch) nous avons entrepris des nouvelles recherches sur la chaleur rayonnant, la force musculaire, la capacité pulmonaire, la force d'inspiration et d'expiration, sur l'état du système nerveux, en nous bassant sur le temps de réaction des reflexes tendineux." . . .

"1. *Rayonnement Calorique.*—Les expériences ont porté sur 4 femmes

point for physiological functions was reached just before menstruation. A quotation from his address delivered before the International Congress in Berlin in 1890 follows:

"In addition to researches on temperature, pulse, blood pressure (Basch spygmanometer), we undertook to make pioneer experiments on caloric radiation, muscular force, pulmonary capacity, inspiration and expiration, and on the state of the nervous system, using the reaction time of the tendinous reflex."

The experiments are described separately thus:

"1. *Caloric Radiation.*—The experiments were made on 4 women, comprising 10 periods. The thermofugostope of Arnshen was used. The tests were always made at the same point on the chest.

"2. *Muscular Energy.*—16 women and 20 menstrual periods. Measurements made with both hands with the Collin dynamometer (with 2 pointers).

"3. *Vital Capacity and Vital Force.*—19 women and 19 periods. Hutchinson spirometer and Waldenburg pneumometer.

"4. *Reaction Time of the Tendinous Reflex of the Knee.*—4 women and 4 menstrual periods. Experiments performed by means of a small hammer especially invented for researches of this kind by Dr. Daniel. (See 'Séances et Memoirs de la Société de Biologie,' 1882, p. 595.)"

In summing up the results of his experiment Van Ott says, "We found that the energy of functions of the female organism is augmented before the beginning of menstruation, and diminished immediately before or with the onset of the hemorrhage.

et 10 périodes menstruelles, pratiquées avec le thermofugostope d'Arnshen; elles ont toujours été faites sur un seul et même point de la poitrine.

"2. *Force Musculaire.*—16 femmes et 20 périodes menstruelles. Mesures prises aux deux mains avec le dynamomètre de Collin (avec 2 aiguilles).

"3. *Capacité Pulmonaire et Force de l'Excursion Pulmonaire.*—19 femmes avec 19 périodes menstruelles. Spiromètre Hutchinson et pneumomètre de Waldenburg.

"4. *Temps de Réaction du Réflexe Tendineux du Genou.*—4 femmes avec 4 périodes menstruelles. Expériences pratiquées avec un petit marteau inventé specialement pour ce genre de recherches par le Dr. Daniel. (Comptes rendus des Séances et Memoirs de la Société de Biologie, 1882, p. 595.)" . . .

"Nous avons trouvé que l'énergie des fonctions de l'organisme féminin augmente avant le début de la menstruation et diminue au contraire immédiatement avant ou avec de début de l'hemorrhagie.

"Je ne veux pas, Messieurs, vous fatiguer par l'énoncé des détails et par l'enumeration de tous les chiffres, car ils seront relatés dans un travail plus considerable qui parâitra sur le sujet. . . .

"Quoique j'ai deja dit que ce schema répresente le type des oscillations de toutes les fonctions sur lesquelles ont porté nos recherches, je dois faire observer que l'excitabilité maxima du système nerveux reste parfois un peu au-dessous, tandis qu'elle atteint son summum pendant la menstruation elle même; ceci est confirmé par l'ensemble de tous les cas observés. Il en est de même du rayonnement calorique, qui atteint son maximum pendant l'écoulment menstruel."

"I will not tire you, gentlemen, with a recital of the details and the enumeration of all the figures, for these will be given in a work much more considerable on this subject."

Unfortunately this promised book never appeared, so far as the present writer is able to discover, and no figures whatever are given in this address. We are not told who were his subjects; whether they were women in the hospital or women who were perfectly well, and normal as to menstruation; whether they knew the purpose of the experiment, or were naïve. For these several reasons it is impossible to examine and analyze Van Ott's data, for purposes of comparison with the present study. The curve which he constructed (Figure 12) is a mere schematic presentation of the general drift of the results ("ce schema répresente le type des oscillations"), and is not platted from any actual figures. Moreover it represents the combination of all four experiments, and it is therefore not known what happened in the case of any individual test; though the author does state that the excitability of the nervous system reaches its climax during menstruation, and that the same is true of caloric radiation. In the light of these last two statements it is somewhat difficult to understand how his "schema" comprising all four tests can indicate such a great drop during menstruation, since in two of the tests the curve reaches its climax at that time. In short, it is regrettable that the data collected by Van Ott are not available.

Clelia D. Mosher,[3] working over ten years later than Van Ott, took daily records of blood pressure on women and men, thus avoiding an error of previous investigators, who neglected to use as a control human beings not subject to the phenomenon in question. Dr. Mosher's experiment is quoted as follows:

"*Method.*—Daily records of the blood pressure were made on 14 persons,—9 women and 5 men. The women were selected as representing normal conditions of menstrual health. The men were all healthy adults, and four were athletic. An attempt was made to continue the record long enough to cover at least two periods of change in pressure;

[3] Mosher, Normal Menstruation and Some of the Factors Modifying It, *Johns Hopkins Hosp. Bull.*, Apr., May, June, 1901.

NOTE.—Ellis (Man and Woman, 1909 ed., p. 286) characterizes Van Ott's curve as "the most accurate." Hall (Adolescence, Vol. I, p. 487) also reproduces Van Ott's curve without critical comment, but mistakenly attributes it to Engelmann, who has reproduced it in his work on "The American Girl of Today." (See Bibliography.)

in some cases the observations extended over 49 days. . . . The blood pressure records were made with the spygmanometer of Mosso. The tracings were taken daily at the same hour, and under uniform conditions, perfect relaxation being secured and all variable factors excluded as far as possible.

"*Conclusions.*—That a rhythmical fall of blood pressure, at definite intervals, occurs in both men and women. The daily records of the blood pressure with the spygmanometer of Mosso on both men and women under similar conditions of life and occupation give curves apparently indistinguishable in character. The fall in pressure in women occurs near or at the menstrual period. In all of the 14 series of records the fall of blood pressure was gradual from the mean average pressure. This from day to day shows oscillations within rather definite limits. The maximum fall of pressure may extend over two or three days and the corresponding rise to normal average pressure is gradual. There is usually a preliminary rise, above the normal average pressure; this occurs from 3-5 days before the onset of the main fall of pressure, which constitutes the principal feature of the rhythm. In every case there was a preliminary fall, abrupt and definite, but usually not so extensive as the main fall of pressure; this preliminary fall was followed by a return to the normal or higher pressure, before the principal fall occurred. In 4 cases there was a distinct rise above the normal after the main fall of pressure, before the return to the normal daily oscillations. These variations were not peculiar to either sex."

Mosher gives no figures and no curves. This article was published as a preliminary report, but, so far as the present writer is able to discover, no subsequent publication of data has been made. It is thus impossible to compare the records in any definite way with the figures of the present study.

The fact that the fluctuating curves of the women subjects were "apparently indistinguishable in character" from those of the men subjects gives rise to the question, whether the fluctuations found by Mosher and previous investigators are to be connected with menstruation as a cause. This, it may be added, is a point which seems to have escaped nearly all writers who have quoted Mosher.[4]

[4] Howell (Text-Book of Physiology, 1908, p. 879) notes that Mosher obtained similar curves for men and women, and suggests that this points to a reproductive cycle in men as well as in women.

F3 had 15 preliminary practice trials previous to Sept. 29.

In platting the curves of F4 individually two menstrual periods are included, in spite of the fact that the first month is much affected by practice, causing the whole curve to take a decided downward slope. In platting the combined curves for all the women subjects, however, only the second menstrual period for F4 is included. These remarks apply also to the pseudo-periods for M2.

To obtain from the present study curves of mental and motor performance which would be comparable with those platted for physiological functioning, the following method was used. Because of the great amount of practice during the first thirty days, which when superimposed upon records for the other months, would skew the curve, the first four weeks of work for each subject were thrown out. This left the record of two menstrual periods for F1, of three menstrual periods each for F2 and F3, and of one menstrual period for F4. The figures for each test for each individual were then arranged in columns, with the five days of the menstrual period at about the center of the series, as in Van Ott's curve, thus:

SECTION FROM THE RECORD OF F2: TAPPING

1st mo.,-etc. 40.0 39.6 39.2	37.4* 38.6* 36.4* 40.8* 39.2*	40.8 39.8 etc.
2d mo.,-etc. 35.4 35.0 39.6	37.0* 37.6* 36.8* 36.4* 35.4*	38.8 36.6 etc.
3d mo.,-etc. 36.2 37.8 36.2	36.6* 36.2* 37.3* 37.4* 36.9*	37.9 36.7 etc.

The corresponding days in each monthly period for a subject in a test were placed one beneath the other as shown above, and the average for each day of the 28 was then computed. Figures 5, 6, 7 and 8 were platted from these averages. It is evident that these curves (except the curve for fatiguability) will be slightly inclined downward, from the first of the month toward the last, because there was some practice, even after excluding the records of the first thirty days. The curves for F1, F2, F3 and F4 are platted separately, to show the individual differences which might appear. The curve for each test is platted separately.

The result agrees in no case with the curve of Van Ott (Figure 12). Nothing like a "wave" is discernible. The curves pursue their course straight across the month, with the familiar irregular variations which are characteristic of all curves of mental and motor work. The curves of M1 and M2 (Figures 9 and 10), platted in the same way as those of the women, from chance series of 28 days each, yield results characteristically differing in no way from those yielded by F1, F2, F3, and F4.

In order further to mass the data it was desired to combine the curves of the four women[5] in each test, i. e., to determine

[5] The record of F6 is not included in these composite curves on account of the irregularity in the occurrence and duration of menstrual periods.

the composite curve of F1, F2, F3, and F4 (1) in tapping, (2) in steadiness, etc. It is evident that in order to effect a proper statistical synthesis of these records it will be necessary first to reduce the records of the three individuals to a common ratio. It will not be productive of reliable results to make use of absolute amounts, as was done when the individuals were considered each by herself. This fact becomes at once clear when we take up a sample from the records. In the steadiness test, e. g., the averages for the first day of the series run thus; respectively: F1—37.0 (contacts), F2—20.0 (contacts), F3—9.3 (contacts), F4—5.0 (contacts). Now, if these four absolute amounts be averaged to obtain the combined curve, it is seen that F1 will have nearly twice as much influence upon it as F2, and four times as much influence as F3, etc. Thus F1 will determine the shape of the curve, merely because she as an individual is much less steady than any of the other subjects; whereas F3, whose record is the most reliable of the four, because it includes the greatest number of trials, will have but little influence in determining the shape of the composite curve, merely because she as an individual is four times as steady as F1, and twice as steady as F2. This principle is applicable in all the tests (except for fatiguability, where the records are already in terms of per cent). For instance, in color naming the slowest person will exert more influence on the composite curve than the most rapid person, merely because her record will be greatest in absolute number of seconds. F1 is like herself from time to time, but unlike F2, F3 and F4 in the traits here measured; F2 is like herself, but unlike F1, F3 and F4, and so forth for the other subjects. Therefore absolute amounts may be averaged to determine a composite curve for a single individual in a single trait; but absolute amounts may not be used to determine a composite curve for many individuals in a single trait.

This was the method of combining the curves. The averages for each individual for each test, used in platting the curves found in Figures 5, 6, 7 and 8 were taken. Each figure was reduced to a per cent of the first figure in its series. Thus, for example, the record of F1 in steadiness, which in absolute amounts runs 37.0, 30.5, 42.0, 26.0, etc., becomes 100.0, 82.4,

113.4, 70.3, etc.; the record of F2 for steadiness, which in absolute amounts runs 20.0, 21.5, 19.3, 12.3, etc., becomes 100.0, 107.5, 96.5, 61.5, etc.; the record of F3 for steadiness, which in absolute amounts runs 9.3, 8.3, 10.2, 13.31, etc., becomes 100.0, 89.3, 110.0, 141.0, etc.; the record of F4, for steadiness, which in absolute amounts runs 5.0, 4.0, 7.0, 6.0, etc., becomes 100.0, 80.0, 140.0, 120.0, etc. These records may now be combined into a curve on the shaping of which each individual exerts an equal fraction of influence. In this curve all individual differences will tend to be equalized, all accidental differences will tend to disappear; and if there be a genuine characteristic effect produced by a phenomenon to which all the women are thus made simultaneously subject, that effect will tend to emerge and lend itself to clear definition. The curves thus platted are found in Figure 11.

These curves (except fatiguability) are all slightly inclined downward from the first of the month toward the last, because of practice. To consider them one by one: *Curve A* (Tapping with the Stylus) shows no effect due to menstruation, except that the record which falls on the first day is equalled only once again during the 28 days, and that on the 28th day, after 14 days of practice which, as may be noted, brings the whole curve gradually downward. This apparent effect is in all probability, however, due solely to chance. Otherwise the curve proceeds straight across the period and across the month with the familiar irregularities indistinguishable from those found in the curves of M1 and M2. *Curve B* (Tapping with the Key) follows the irregular course of the ordinary practice curve. It is more irregular than *Curve A* because it is composed of the records of but two individuals (F2 and F3). *Curve C* (Steadiness) shows that the subjects were very steady on the first two days of the critical period. The record of the second day is the steadiest of the 28. These conclusions regarding a genuine characteristic effect on any day are, however, to be advanced with much caution. The curves of M1 and M2 also show "lowest points," as for example, in M1's curve for steadiness the day preceding the pseudo-critical period is distinctly the best record of the 28, and if it occurred on the curve of the women might well be said to indicate maximum steadiness on the day preceding menstruation.

The curves for speed and accuracy of perception (*Curve D*), for controlled association (*Curve E*), for fatiguability (*Curve F*), show no extraordinary deviations whatever during menstruation. The curves proceed as the ordinary practice curve does, slightly inclined downward, and suggesting neither remarkable inferiority nor remarkable superiority of performance on the first day nor any other day of the critical period.

No clear and valuable result would be expected from averaging all curves for all individuals for all tests together to determine the presence of a "cycle" or "wave," because there is no reason to assume that if menstruation exerted a real influence upon the processes here measured, that influence would be the same on all processes. For instance, menstruation might cause a subject to tap more rapidly, but to associate more slowly, and thus a real "wave" might be established in each of these processes. But to combine them would obviously just equalize the differences, and obscure the form of the "wave." However, a total curve composed of *Curves A, B, C, D, E,* and *F* was platted for purposes of comparison with Van Ott's Curve, which purports to show the combined behavior of several physiological processes. (See Figure 12.) This composite curve is designated as *Curve G* and is found in Figure 12, running beneath Van Ott's "schema." Each point on it is the average of 66 figures.

Van Ott gives no satisfactory account of the statistical treatment of his figures. He does not give *any* mathematical demonstration of his results, leaving these, as he says, for a subsequent publication, which was never made. Consequently it is impossible to compare his curve and *Curve G* unit for unit. Indeed it is not at all clear that Van Ott's curve is mathematically true in any sense, even in the preservation of relative proportions. Nevertheless *Curve G* is given graphically in company with Van Ott's curve. It is at once evident that the only consistent tendency which *Curve G* shows is the slight gradual descent due to practice between the first and last of each month. It is not uninteresting to observe that the figure indicating greatest average efficiency in all tests chances to fall, as a matter of fact, on the second day of the critical period.

Curve G' is a composite curve showing the total performance of M1 and M2 for four pseudo-cycles (3 cycles for M1 and 1 cycle for M2) of 28 days each, in six various kinds of work.

The averages used in platting Figures 9 and 10 were converted into per cent of the initial day in each test, exactly as in the case of the women, and then were combined into a total curve which corresponds exactly to *Curve G,* and is comparable with it unit for unit. *Curve G'* thus may be, and is, platted on the same base and scale as *Curve G.* (See Figure 12.) We have now a graphic presentation of the monthly curve of work for the women, as compared with that for the men, and with Van Ott's curve. *Curve G* follows the same trend as *Curve G'; they* constantly touch and cross throughout their course. *Curve G'* is, of course, not so regular as *Curve G* because it is composed of the records of but two individuals, and accidental differences are not so well equalized. As an illustration of the ease with which the investigator may be led into deducing false conclusions in studies of this kind, note that *Curve G'* shows a considerable drop just before the critical period. Had this occurred on the curve of the women, the conclusion would have been suggested that this must be ascribed to approaching menstruation as a cause.

It must be concluded that the curves platted for mental and motor performances do not correlate with those previously platted for physiological functioning. An interesting confirmation of the reliability of this conclusion is found in the work of Frederick Lyman Wells.[6] In order to determine the relation of practice to individual differences he experimented with ten subjects. He describes his experiment as follows:

"A group of ten subjects underwent these tests daily, six days in the week, for a period of thirty experimental days. The subjects were nurses in the McLean Hospital, five men and five women, of ages varying from 21 to 35 years. The work performed each day consisted of five minutes of addition, and on the first ten days one record of the number-checking test; while on the succeeding twenty days, five records of the number-checking test were executed each day. The times of day were the same for each subject."

[6] F. Lyman Wells, Relation of Practice to Individual Differences, *Am. Jour. Psych.,* Jan., 1912, p. 77.

Note.—Wells platted his curves in terms of *amount of work done,* the time remaining constant; hence his curves showing improvement run *upward,* while the practice curves of the present study run *downward* because they are platted in terms of the *time of performance,* the amount of work remaining constant (except in the steadiness test, and here the practice curve also runs *downward* because the effort was to do *as little* as possible, that is, to make as few touches as possible, instead of *as much as possible*).

The curves from Wells's study are reproduced in Figures 13, 14, 15 and 16. Wells took no note whatever of the occurrence of menstruation in the five women subjects, so we do not know where on their curves these periods fell; and it is impossible to tell by inspection in any case which were the days presumably affected. The curves of the women show no characteristic lapses from efficiency, but are quite indistinguishable in course and form from those of the men, as in the case of the present study.

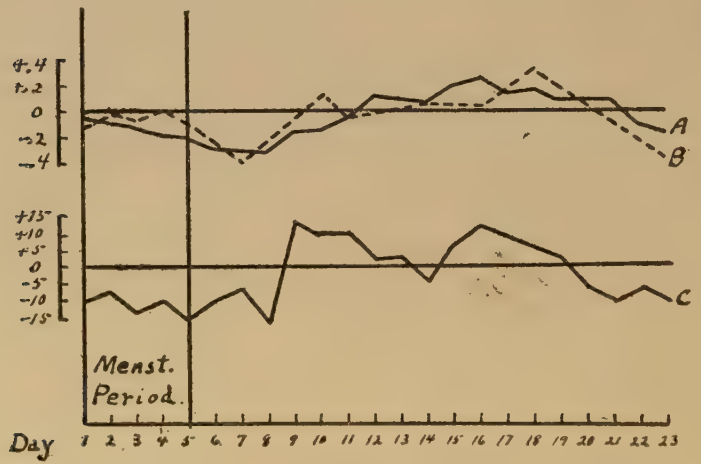

FIGURE 4.—Samples of Stephenson's Curves, after Jacobi.

Reproduced from *Amer. Jour. Obstet.*, 1882, Vol. 15.
Curve A = Temperature (average 99.31).
Curve B = Pulse.
Curve C = Urea (average 25.2 grms.).
These are the average curves of three total cycles of twenty-three days each. The records indicate the daily deviations above and below the average.

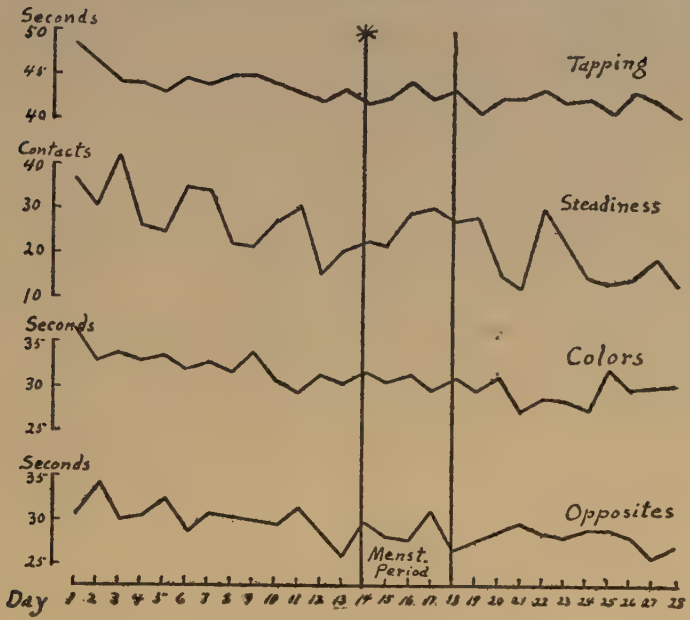

FIGURE 5.—F1. Average Monthly Course of Each Test.

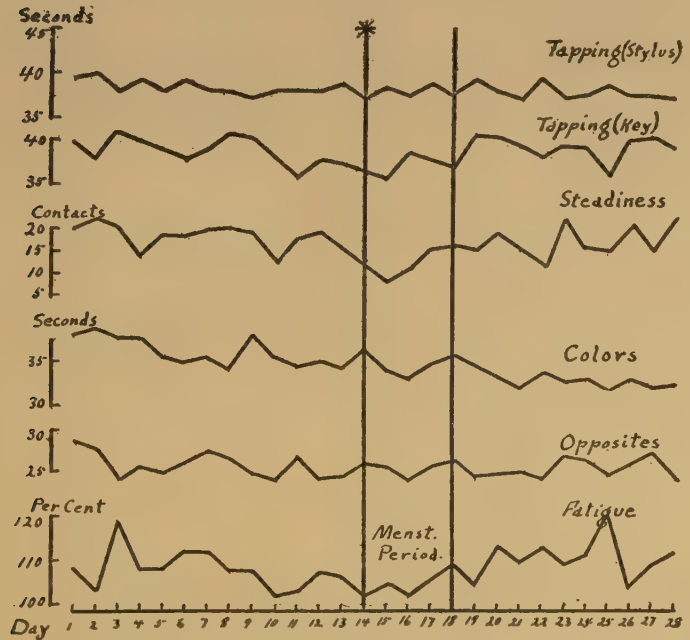

FIGURE 6.—F2. Average Monthly Course of Each Test.

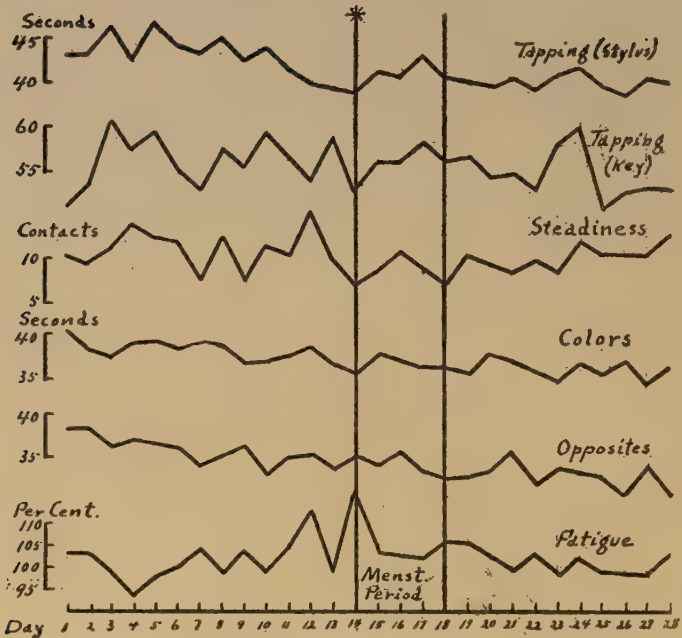

FIGURE 7.—F3. Average Monthly Course of Each Test.

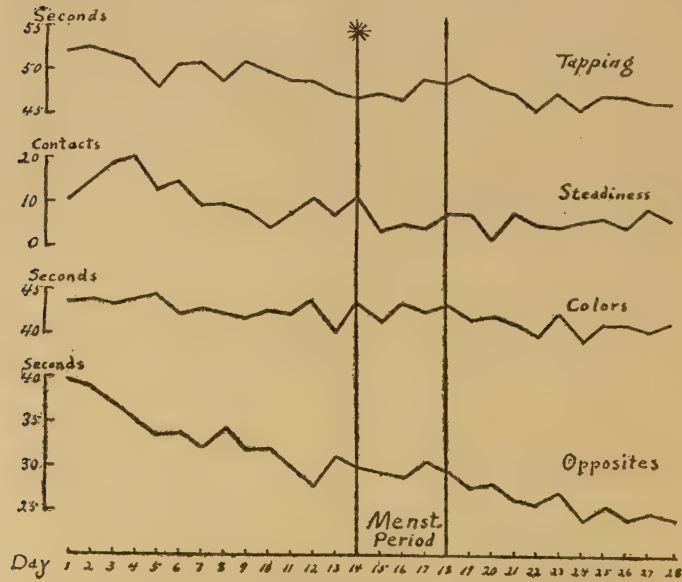

FIGURE 8.—F4. Average Monthly Course of Each Test.

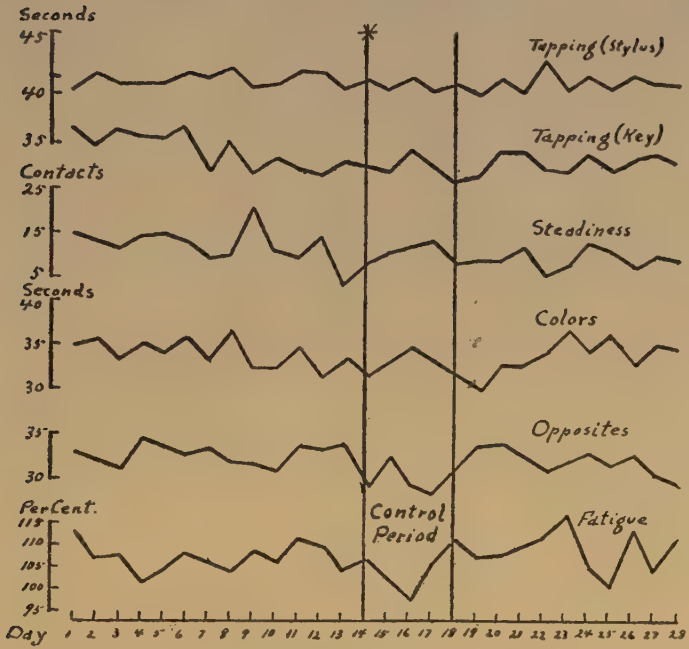

FIGURE 9.—M1. Average Monthly Course of Each Test.

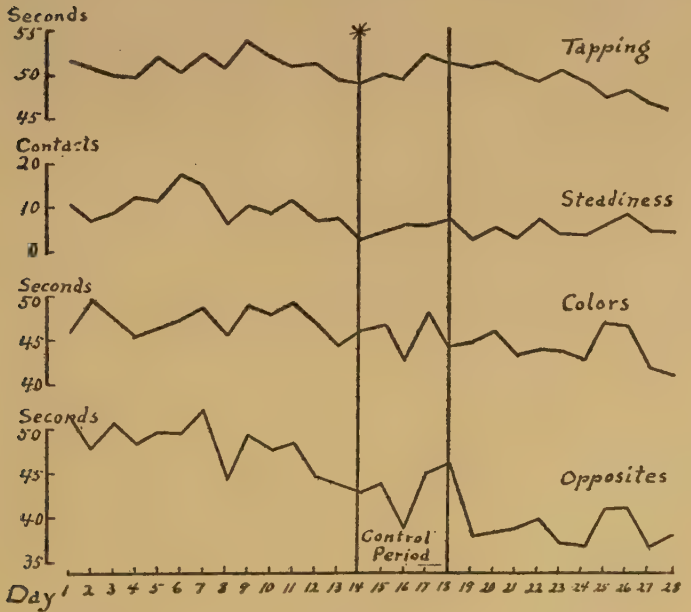

FIGURE 10—M2. Average Monthly Course of Each Test.

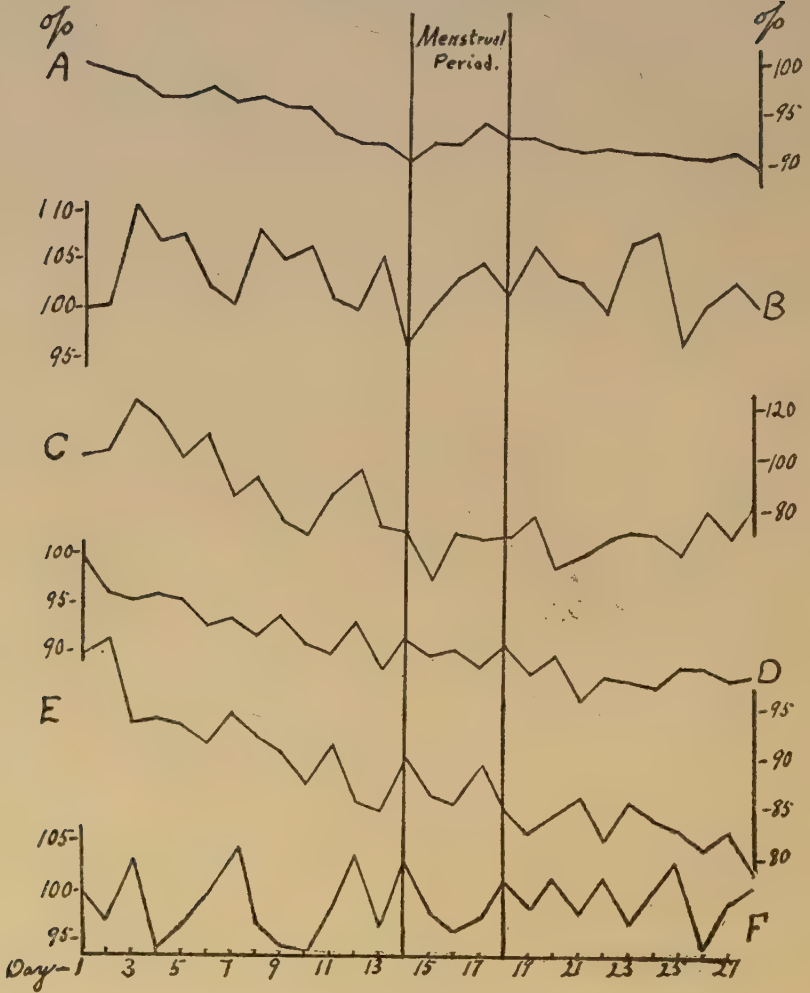

FIGURE 11

Curve A: Tapping with Stylus. (Subjects F1, F2, F3 and F4.) Abscissas indicate successive days; ordinates indicate speed of performance on successive days in terms of per cent of the initial day.

Curve B: Tapping with Key. (Subjects F2 and F3.) Abscissas indicate successive days; ordinates indicate speed of performance in terms of per cent of the initial day.

Curve C: Steadiness. (Subjects F1, F2, F3 and F4.) Abscissas indicate successive days; ordinates indicate number of involuntary movements (tremor) per 30 seconds, on successive days, in terms of per cent of the initial day.

FIGURE 11—(Continued).

Curve D: Color Naming. (Subjects F1, F2, F3 and F4.) Abscissas indicate successive days; ordinates indicate speed of performance on successive days, in terms of per cent of the initial day.

Curve E: Opposites. (Subjects F1, F2, F3 and F4.) Abscissas indicate successive days; ordinates indicate speed of performance on successive days, in terms of per cent of the initial day.

Curve F: Fatiguability. Tapping with Key. (Subjects F2 and F3.) Abscissas indicate successive days; ordinates indicate degree of fatigue on successive days in terms of the index of fatigue.

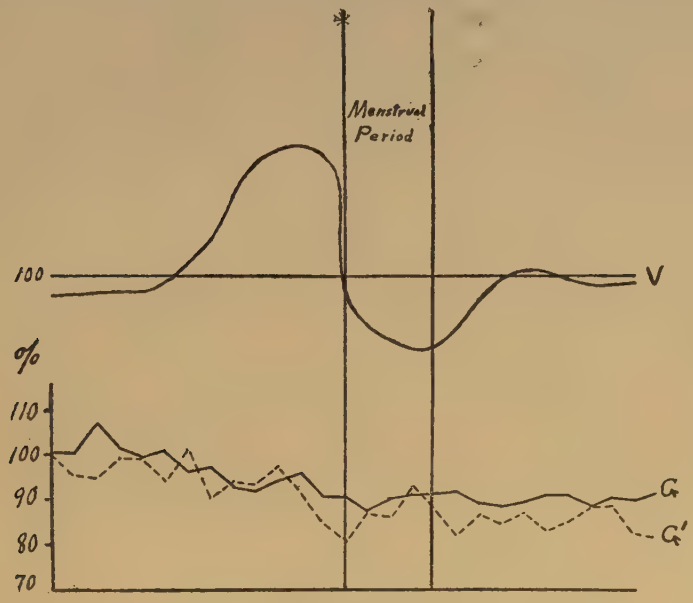

FIGURE 12

Curve G: Composite curve composed of *Curves A, B, C, D, E* and *F.* Shows total performance of F1, F2, F3, and F4; includes ten cycles of 28 days each, and six various kinds of performance. Composed for purposes of comparison with Van Ott's Curve (*Curve V*), and with the composite curve of M1 and M2 (*Curve G'*).

Curve G': Composite curve showing the total performance of M1 and M2; includes five pseudo-cycles of 28 days each, and six various kinds of performance. Abscissas indicate successive days; ordinates indicate performance in terms of per cent of the initial day. Thus *Curve G* and *Curve G'* may be and are platted on the same base and scale.

Curve V: Van Ott's Curve of the monthly cycle, showing the combined behavior of blood pressure, temperature, pulse, caloric radiation, vital capacity, and reflex action. (See p. 70 of this monograph.)

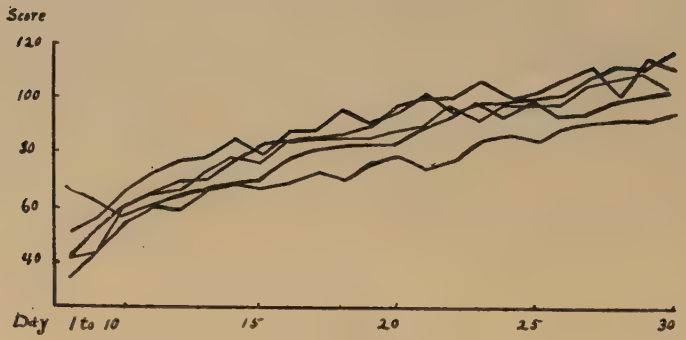

FIGURE 13. (Wells)—Number-checking Test—Women.

The score indicates the number of o's checked in one minute, on each of 30 successive days, by five different individuals, each curve representing a single individual.

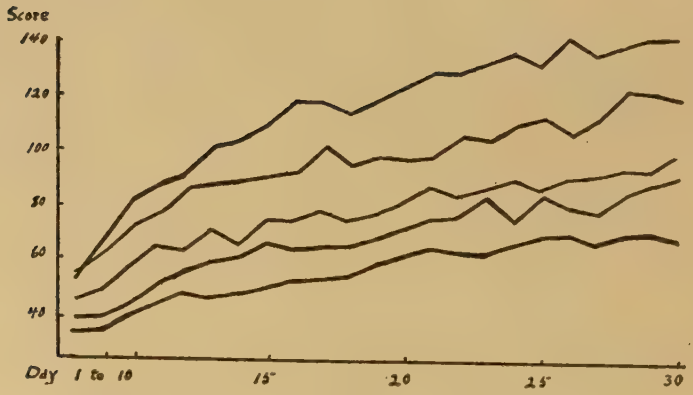

FIGURE 14. (Wells)—Number-checking Test—Men.

The score indicates the number of o's checked in one minute, on each of 30 successive days, by five different individuals, each curve representing a single individual.

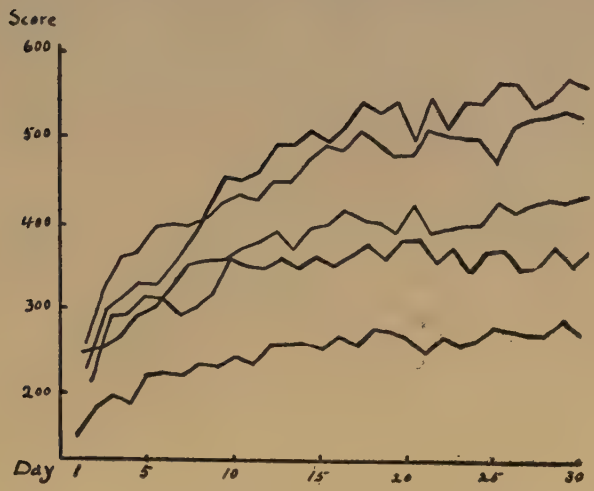

FIGURE 15. (Wells)—Addition Test—Women.

The score indicates the number of additions made in five minutes, on each of 30 successive days, by five different individuals, each curve representing a single individual.

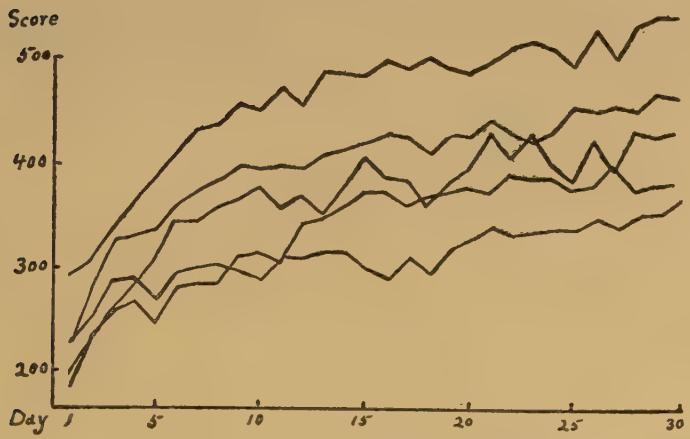

FIGURE 16. (Wells)—Addition Test—Men.

The score indicates the number of additions made in five minutes, on each of 30 successive days, by five different individuals, each curve representing a single individual.

X

AN EXTENSIVE EXPERIMENT: STEADINESS, TAPPING AND CONTROLLED ASSOCIATION (OPPOSITES)

Aim, Scope and Method

It was felt to be highly desirable that as many women as possible should be tested in order that some intelligent idea might be gained as to the range of individual differences which might exist in the matter of mental and motor ability during menstruation. Accordingly, through the great courtesy and kindness of Miss Caroline Stackpole and Professor Maurice Bigelow of the Department of Biology in Teachers College, Columbia University, an invitation was extended to the women students in that department to take part in an experiment as outlined below. Seventeen women volunteered their services. All of them were professional women, their professions including teaching, nursing, sanitary engineering, and domestic supervision. They ranged in age from 20 to 40 years. They were not selected by the experimenter on any basis except that described above, i. e., their interest in responding to an invitation to assist in executing a piece of scientific work. It is, however, true that they were a selected group of women, for their presence as professional workers and students in a great university indicates at once that the pathological, the feeble, the ignorant and the lazy had at least been eliminated from their group. Some of them knew the purpose of the experiment, some of them suspected it, and some were ignorant of it.

The aim of the extensive experiment was the same as that of the intensive experiment.

The method of the extensive experiment was very much less exact than in the case of the intensive work. The tests were given in the same order at each trial, but they were not always given at the same hour of the day, nor by the same person.

Instead of being given daily, the tests were made only on every third day. The experiment extended over thirty days, thus yielding ten records, and including at least one menstrual period, for every subject. For the sake of reliability, *two trials* were made at each sitting, and the record for any given test on any given subject for any given day is the average of *two* trials. At each sitting a list of questions (to be discussed later), was answered by each subject.

The scope of the intensive experiment was greater as respects number of subjects included; it was less as respects number of traits tested and period of time covered. Only three of the tests used in the intensive work were used here, i.e., (1) Steadiness, (2) Tapping, (3) Opposites.

Steadiness

The data from the extensive experiment will not be presented in great detail, as were the data from the intensive experiment. All the data are, however, on record at Teachers College, and may be consulted for purposes of criticism or comparison by properly qualified persons.

The method of presenting the data is as follows: Each record was reduced to a multiple of the Mean Variation of the group by first obtaining the variation of each individual at each trial from the average of the group at that trial, and then dividing these individual variations through by the Mean Variation of the group. Thus, to illustrate, the first trials for the seventeen individuals in the tapping test ran as follows:

Subject	A	47.0 sec.
"	B	68.5 "
"	C	57.9 "
"	D	58.7 "
"	E	53.4 "
		etc.

When these records for all seventeen subjects were averaged, the result was 60.9 seconds (the average performance of the group as a whole). When the variation of each individual from this average was found these variations ran as follows:

Subject	A	+13.9 sec.
"	B	— 7.6 "
"	C	+ 3.0 "
"	D	+ 2.2 "
"	E	+ 7.5 "
		etc.

The + sign signifies better than the average of the group, and the — sign signifies poorer than the average of the group. When these variations are averaged, the Mean Variation for the group of seventeen is found to be ± 5.3.

Now dividing each individual variation through by this Mean Variation of the group, we have the record of each individual for the first trial in the tapping test reduced to a multiple of the Mean Variation of the group. The record now runs as follows, and these are the figures which appear in Tables XVIII, XIX, and XX:

Subject	A	+2.60 sec.
"	B	—1.43 "
"	C	+0.57 "
"	D	+0.41 "
"	E	+1.41 "

The same procedure was carried through for the second trial, the third trial, etc., in all three of the tests, until every individual record had been reduced to a multiple of the Mean Variation of the group. This method tends to minimize the influence of individual differences in absolute ability, of practice, and of other factors that might tend to obscure the specific problem here under consideration. The method has been used by Norsworthy[1] and by Sleight,[2] and has been recommended by Thorndike.[3]

The next step in the statistical procedure was to place all the critical days in two columns, with the ordinary days running out from the critical period in both directions as might chance. It would obviously happen by chance that certain of the subjects would be menstruating just as the experiment was begun; others, in the midst of the experiment; others, at the very end of the experiment. For example, the critical period for Subject A occurred at the very end of the experiment; for Subject B it occurred in the midst of the experiment; for Subject C it occurred on the fourth trial. Thus their records are arranged as follows:

(A) +2.60	+2.10	+2.60					+2.80	+3.60						
			(B) —1.43				—1.16	—0.69		—0.05	—2.00	—0.62	+0.10	
				(C) +0.57	+0.17	+1.53	—0.06	+1.67		+1.47	+1.30	+1.60	+0.89	+1.0
	etc.		etc.		etc.			etc.			etc.	etc.		etc.

[1] Naomi Norsworthy, The Psychology of Mentally Deficient Children, 1906.

[2] W. G. Sleight, Memory and Formal Training, *Brit. Jour. Psych.*, 1911.

[3] E. L. Thorndike, Educational Psychology, 1910.

There are two columns of numbers in the critical period because for about one-half of the subjects two of the five days of the menstrual period chanced to be included.

When the records for the seventeen subjects had been all arranged (as may be seen in Tables XVIII, XIX, and XX) the columns were added algebraically, and the average efficiency of the group as a whole at every trial was found. Tables XVIII, XIX, and XX present the complete data as thus treated, and show the individual records, as well as the performance of the group as a whole.

Table XVIII gives the record of the steadiness test. If there were a characteristic inefficiency at critical periods for the group as a whole, we should expect that the average performance of the group at the critical period would be registered as poorer than on any or most of the other days. Inspection shows that on 7 of the 17 ordinary days the records were the same as or poorer than the record of the group at the critical period.

Tapping

The tapping test was exactly the same as that described in the intensive experiment under Pat I of the tapping test. (See p. 15.) The data were treated and are presented exactly as in the case of the steadiness test just described. Table XIX includes all the records made in the tapping test, each record here being presented as a multiple of the Mean Variation of the group. Inspection shows that on 11 of the 17 ordinary days the records were the same as or poorer than the record of the group at the critical period. This result indicates no influence either favorable or detrimental on speed of voluntary movement at the menstrual period.

Opposites

The opposites test was exactly the same as that described under the intensive experiment. The data were treated and are presented in Table XX, in exactly the same way as in the steadiness and tapping tests just described. Inspection shows that on 6 of the 17 ordinary days the records were the same as or poorer than the record of the group at the critical period. In 4 out of the 6 cases the performance of the group on ordinary days was *much* poorer than at the critical period.

Miscellaneous Observations

At each sitting every subject recorded answers to the following questions:

1. Did you retire at the usual hour last night?
2. Were your evening occupations of the usual sort?
3. Did you sleep as well as usual?
4. Did you rise at the usual hour?
5. Did you lunch as usual? Was your diet of the usual kind?
6. Have you had any digestive disturbance?
7. Have you taken exercise to-day? Usual amount? Unusual?
8. Have you experienced any emotional disturbance in the last 24 hours? Irritation? Depression? Excitement? Anger? etc.
9. Have you suffered in any way during the last 24 hours?
10. Note the beginning of menstruation.
11. Note the end of menstruation.

Many of these questions have no direct bearing on the psychological problem of determining mental and motor efficiency at a given time. But the long list of questions served to divert attention from the last two questions in the case of those who did not know the exact purpose of the experiment, and all of the questions were important as bearing on measurements of blood pressure, temperature, and pulse which were taken throughout the month by Miss Stackpole.

The purpose of this study, as has been stated, was simply to determine whether there is any measurable change in efficiency in mental and motor processes during menstruation. It was no part of the original aim to go into the matter of introspection, or to discuss the affective processes. However, a brief summary of the replies obtained from these questions will not be entirely out of place here.

Of the 17 subjects, 4 reported *physical disturbances* on critical days, as follows:

Subject K—"Abdominal discomfort, and slight headache." (Headache also reported by this subject on days when she was not menstruating.)

Subject I—"Very slight abdominal pain."

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